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Brackish-Water Ostracoda (Crustacea) from the Obitsu River Estuary, Central Japan

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The brackish-water ostracod fauna was surveyed for almost two years at 17 points representing typical environments, such as foreshore sand flat, back marsh, and tidal creek, in the intertidal zone of the Obitsu River Estuary, Chiba Prefecture, central Japan. Twenty-one species belonging to 17 genera and 10 families were identified. In addition to the description of one new genus, *Palusleptocythere*, and four new species, *Pontocythere xiphoidea*, *Palusleptocythere migrans*, *Loxoconcha kosugii*, and *Cytherois ikeyai*, chitinous parts are described for the first time for four previously described species, *Spinileberis pulchra* Chen, 1982, *Angulicytherura? miii* (Ishizaki, 1969), *Semicytherura wakamurasaki* Yajima, 1982, and *Loxoconcha pulchra* Ishizaki, 1968. Furthermore chitinous parts of male *Dolerocypria mukaishimensis* Okubo, 1980 are also shown for the first time. This is the first report on an ostracod fauna from a shallow estuarine environment in either Japan or any adjacent area.

Key Words: Crustacea, Ostracoda, brackish-water, estuary, taxonomy, Tokyo Bay.

Introduction

Many descriptive studies on brackish-water ostracods from inner bay areas in Japan have been published since the 1960s: Uranouchi Bay (Ishizaki 1968), Lakes Shinji-ko and Nakanoumi (Ishizaki 1969), Aomori Bay (Ishizaki 1971), Lake Hamana (Ikeya and Hanai 1982; Ikeya *et al.* 1985), Ise Bay (Bodergat and Ikeya 1988), Toyama Bay (Ishizaki and Irizuki 1990), Sendai Bay (Ikeya and Itoh 1991), Otsuchi Bay (Ikeya *et al.* 1992; Tanaka *et al.* 1998), and Hiuchi-nada Bay (Yamane 1998). In these studies, the water depths of the examined materials were all greater than several meters, because the samples were collected by dredging and coring from ships. In general, the purpose of these studies was to present indices of brackish-water species useful for the reconstruction of paleoenvironments, rather than to describe the extant ostracod fauna. As a result, descriptions of Japanese brackish-water ostracods have emphasized carapace morphology, which is preserved in fossils, and tended to omit appendage descriptions. The lack of information on soft parts frequently makes the identification of extant species difficult.

Environments of less than a few meters depth have not previously been regarded as important sedimentary provinces in Japan; paleontological interests have concentrated on inner bay environments deeper than the intertidal zone. An-

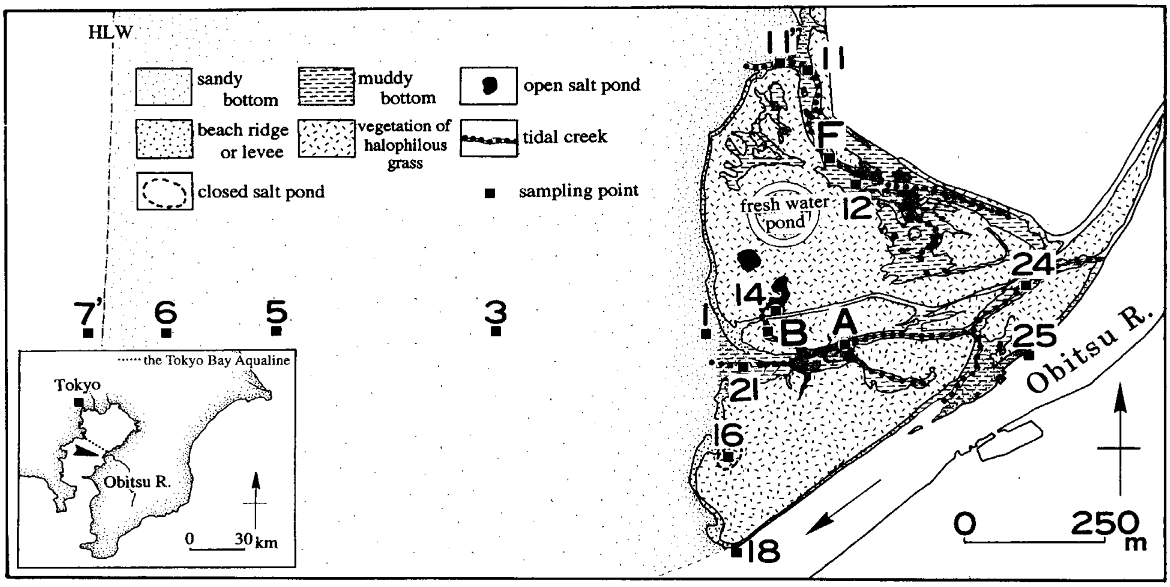

Fig. 1. Location and sediment distribution of the study area with sampling points for ostracods. Muddy bottom areas become submerged during high tide. [Adopted from Tsukagoshi 1994]

other reason for the lack of information on shallow brackish ostracod faunas is the rapid and major destruction of natural seacoast environments in Japan. For half a century, the seacoasts have been subjected to man-induced change on a large scale. Brackish-water environments are the first target of marine reclamation. As a result, lagoons and swamplands in Japan have disappeared as cities and industrial areas have rapidly grown, making the detailed documentation of many localities and their faunas difficult, if not impossible.

The lower reaches of the Obitsu River constitute the only remaining natural estuarine locality in the metropolitan area around Tokyo. This area has many of the characteristic geographic features of a natural estuary, e.g., sand flats, dunes, back swamps, and tidal creeks. Along the opposite side of Japan, the Sea of Japan coast is relatively unexploited, but natural features such as these cannot develop because of the small difference between low and high tide levels there. Therefore, the almost completely preserved estuarine character of the Obitsu River is now very rare in central Japan; as a consequence, it offers a source of valuable data.

The present taxonomic paper begins to make up for the lack of information on intertidal brackish-water ostracod faunas in Japan, and it should also prove useful for studies involving the reconstruction of paleoenvironments. Recently, a number of studies of Holocene deposits in Japan, which mostly consist of brackish-water sediments, have been carried out (Ishizaki 1984; Ikeya *et al.* 1987; Kamiya and Nakagawa 1993; Tsukagoshi *et al.* 1994; Ikeya 1995; Irizuki *et al.* 1998). The need for descriptions of ostracod faunas from equivalent modern environments has been urgently noted by researchers working on Quaternary paleoecology. The present paper will satisfy this lack in part, and it will also provide a baseline record of this changeable and delicate environment, against which future surveys may be compared.

Study Area and Materials

The Obitsu River originates in the central Boso Peninsula and flows into Tokyo Bay. In the center of the study area, a beach ridge (*ca* 2.5 m above sea level) runs north-south and creates a boundary between the foreshore and the back swamp. The foreshore is more than 1 km wide and its western edge adjoins the front of a delta in the sublittoral zone. The back swamp consists of salt ponds, muddy tidal creeks, and vegetation of halophilous grass. Some salt ponds are closed while others are open, connected to the foreshore through tidal creeks during the high tide. A natural levee is developed along the northern side of the main stream of the Obitsu River. The maximum tidal amplitude is approximate 200 cm and this occurs in spring.

The material collected for the present study was surficial sediment from the uppermost 5 mm of the active layer. Sampling was carried out during low tide on alternate months from November, 1997 to September 1998. Seventeen points were selected as representative localities in the estuary (Fig. 1). At sampling points where the water depth was less than 20 cm, the upper layer of sediment was scooped into a plastic bottle using a spoon (a flat spoon of 12×15 cm or a rectangular spoon of 4×7 cm, depending on the degree of surface irregularity). A dustpan with a long handle and a plankton net were used for collecting sediment at points where the water depth was more than 20 cm. Sediment samples were collected 200 cc each from every locality. The sediment type and salinity at each sampling point are shown in Table 1. Salinity was measured by an electric salinometer (HORIBA, SH-7) while collecting samples at low tide. Lists of ostracod species occurring in the study area and their densities in May and July are shown in Tables 3 and 4, respectively. Size dimensions, site of occurrence, and SRDP's of all species

Table 1. Bottom sediment and salinity at each sampling locality.

Locality No.	Bottom sediment	Salinity (‰)*	Remarks
1	medium sand	>20	tidal flat
3	medium sand	*ca* 25	tidal flat
5	medium sand	*ca* 25	tidal flat
6	medium sand	*ca* 25	tidal flat
7'	fine to medium sand	*ca* 25	edge of tidal flat
11	sandy mud	*ca* 20	tidal creek
11'	medium sand	*ca* 20	tidal creek
12	mud	22–30	tidal flat
14	mud	2–25	opened salt pond
16	mud	8–24	closed salt pond
18	medium sand	6–19	slope of tidal bank
21	sandy mud	9–24	mouth of branch stream
24	sandy mud	6–21	branch stream
25	muddy sand	>3	main stream of the river
A	mud	7–23	branch stream
B	sandy mud	4–25	waterway from salt pond
F	silty mud	22–27	tidal flat

* The salinity at each locality was measured at around the time of lowest low tide. The values were influenced by rainfall.

Table 2. Classification of 21 ostracod species found in the study area.

Superfamily	Family	Subfamily	Tribe	Genus	Species
Cypridoidea Baird, 1845					
	Ilyocyprididae Kaufmann, 1900				
		Ilyocypridinae Kaufmann, 1900			
				Ilyocypris Bardy and Norman, 1889	
					Ilyocypris dentifera Sars, 1903
	Candonidae Kaufmann, 1900				
		Paracypridinae Sars, 1923			
			Thalassocypridini Hartmann and Puri, 1974		
				Dolerocypria Tressler, 1937	
					Dolerocypria mukaishimensis Okubo, 1980
Cytheroidea Baird, 1850					
	Cytherideidae Sars, 1925				
		Cytherideinae Sars, 1925			
				Perissocytheridea Stephenson, 1938	
					Perissocytheridea? japonica Ishizaki, 1968
		Cushmanideinae Puri, 1974			
				Pontocythere Dubowsky, 1939	
					Pontocythere miurensis (Hanai, 1959)
					Pontocythere xiphoidea n. sp.
	Leptocytheridae Hanai, 1957				
				Callistocythere Ruggieri, 1953	
					Callistocythere pumila Hanai, 1957
				Ishizakiella McKenzie and Sudijono, 1981	
					Ishizakiella miurensis (Hanai, 1957)
				Palusleptocythere n. gen.	
					Palusleptocythere migrans n. sp.
	Cytheridae Baird, 1850				
				Spinileberis Hanai, 1961	
					Spinileberis pulchra Chen in Hou *et al.*, 1982
					Spinileberis quadriaculeata (Brady, 1880)
	Hemicytheridae Puri, 1953				
		Hemicytherinae Puri, 1953			
				Aurila Pokorný, 1955	
					Aurila disparata Okubo, 1980
				Robustaurila Yajima, 1982	
					Robustaurila ishizakii (Okubo, 1980)
	Trachyleberididae Sylvester-Bradley, 1948				
		Ptterygocytherinae Puri, 1957			
				Bicornucythere Schornikov and Shaytarov, 1979	
					Bicornucythere bisanensis (Okubo, 1975)
	Cytheruridae G. W. Müller, 1894				
		Cytherurinae G. W. Müller, 1894			
				Cytherura Sars, 1866	
					Angulicytherura? miii (Ishizaki, 1969)
				Hemicytherura Elofson, 1941	
					Hemicytherura tricarinata Hanai, 1957
					Hemicytherura sp.
				Semicytherura Wagner, 1957	
					Semicytherura wakamurasaki Yajima, 1982
	Loxoconchidae Sars, 1925				
		Loxoconchinae Sars, 1925			
				Loxoconcha Sars, 1866	
					Loxoconcha pulchra Ishizaki, 1968
					Loxoconcha kosugii n. sp.
				Cytheromorpha Hirschmann, 1909	
					Cytheromorpha acupunctata (Brady, 1880)
	Paradoxostomatidae Brady and Norman, 1889				
		Paradoxostomatinae Brady and Norman, 1889			
				Cytherois G. W. Müller, 1884	
					Cytherois ikeyai n. sp.

are compiled in Table 5. Classification of 21 ostracod species found in the study area is shown in Table 2.

All illustrated and type specimens are deposited in the collection of the Shizuoka University Museum, identified by numbers with the prefix SUM-CO.

Abbreviations. Av, average; LV, left valve; N, individual number; OR, observed range; RV, right valve; SRDP, salinity range of main distributional points of each species at low tide.

Systematics

Ilyocypris dentifera Sars, 1903
(Fig. 2A–D)

Ilyocypris dentifera Sars, 1903: 38, 39, pl. 4, figs 8, 8a–c; Victor and Fernando 1980, figs 1–38.
Ilyocypris angulata Sars, 1903: 39, 40, pl. 4, figs 9, 9a; Okubo 1974: 48–50, figs 1, 2; Ikeya *et al.* 1985, pl. 1, figs 6, 9. [Synonymized by Victor and Fernando 1980]

Diagnosis. Carapace outline in dorsal view spindle-shaped with two prominent sulci and a few nodes. Carapace surface covered with deep, fine pits. Adductor muscle scars situated in deep fossa. Short small spines on anterior and posterior margins.

Remarks. Soft parts of this species were illustrated as *I. angulata* by Okubo (1974). This species is generally known as a fresh-water taxon, but in the present survey it occurred in saline water of approximate 21‰.

Dolerocypria mukaishimensis Okubo, 1980
(Figs 2E–J, 3, 4)

Dolerocypria mukaishimensis Okubo, 1980: 20, fig. 2; Hiruta and Smith 2001, fig. 15E.
Dolerocypria mukaishimense: Okubo 1991: 124, fig. 2a.

Diagnosis. Flattened sub-triangular carapace outline in lateral view, without conspicuous differences between male and female. Greatest height a little in front of mid-length (Figs 2E, F, 3A). Ventral margin almost straight with slight concavity in middle. Carapace surface smooth. In male copulatory organ (Fig. 4E), basal capsule semicircular and distal lobe indivisible and sub-trapezoidal. Copulatory duct long and sinuous (forms complex series of loops), with marked distal taper. Two small processes present medially, cigar-like structure at base of distal lobe and shorter structure located mid-ventrally on basal capsule.

Description. Carapace translucent. Transition between dorsal and postero-ventral margin very narrowly rounded, almost pointed. Anterior and posterior marginal infoldments wide; line of concrescence smooth and very close to outer margin; marginal pore canals short and straight. Hingement (Fig. 2J): modified adont, i.e., in RV, simple bar bearing small knob interlocking with corresponding socket of LV. Muscle scars: row of four suboval scars, fused scars posterior to this row. Antennule (Fig. 3B): 7 articulated segments; 1st and 2nd segments almost

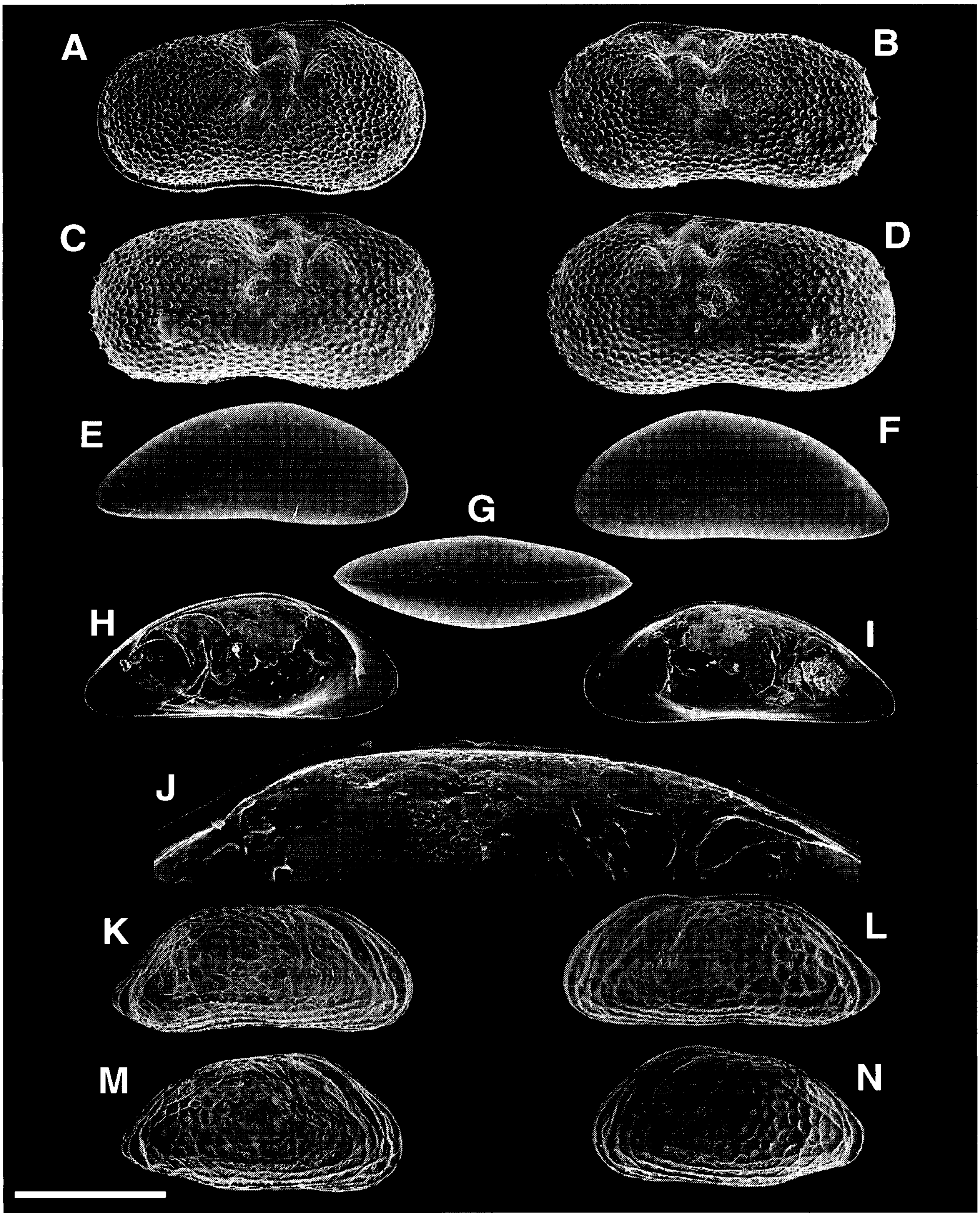

Fig. 2. *Ilyocypris dentifera* Sars, 1903 (A–D), *Dolerocypria mukaishimensis* Okubo, 1980. (E–J), and *Perissocytheridea? japonica* Ishizaki, 1968 (K–N). A, male carapace in external right lateral view (SUM-CO-1101); B, male LV in external view (SUM-CO-1102); C, D, female RV and LV in external lateral view (SUM-CO-1103); E, RV in external lateral view (SUM-CO-1104); F, LV in external lateral view (SUM-CO-1105); G, carapace in external dorsal view (SUM-CO-1106); H, male LV in internal lateral view (SUM-CO-1107); I, male RV in internal lateral view (SUM-CO-1108); J, hingement of male RV (SUM-CO-1108); K, male carapace in external

fused; spatula-like seta present at end of 7th segment. Antenna (Fig. 3C, C', D, D'): 6 articulated segments; 4th and 5th podomeres distinctly divided in male but fused in female; fourth podomere of male with 1 seta bearing trumpet-like structure and another stout, non-trumpet-like seta distally; 4 long, 1 medium, and 1 short swimming setae on 3rd podomere (gap between 4 long setae and medium long seta); 3 large terminal claws in males and 4 in females. Mandible (Fig. 3E, E'): 5 articulated segments; coxa bearing teeth and 2 comb-like seta at anterior end and 1 seta on anterior distal margin; basis (2nd segment) bearing small branchial plate with plumose setae; 2 big setae with ramifications at regular intervals present on posterior margin of 1st segment of endopodite; 3rd segment of endopodite bearing 4 claw-like setae at distal end. Maxillule (Fig. 4A, A'): thin branchial plate with 17–24 setae; basal podomere bearing palp and 3 endites; palp with 9 simple setae, 3 plumose setae, and seta with ramifications at regular intervals; 3 endites bearing several setae. Fifth limb (Fig. 4B, B'): thin branchial plate with spinules; 13 plumose setae at anterior end; 2 plumose setae and 3 setae directed posteriorly with short, fine hairs on ventral margin. Walking legs (Fig. 4C): 5 articulated segments; very long claw-like seta present at distal end of 5th segment. Cleaning limb (Fig. 4D): 4 articulated segments; very long and stout reflexed seta with comb-like distal setules. Furca (Fig. 4G): 1 seta and 2 strong distal claws with distal serration. In female genital lobe, oval capsule containing meandering duct-like structure (Fig. 4F, F').

Remarks. The male copulatory organ (Fig. 4E) is in an non-copulation position. Unknown organs were observed (Fig. 4I, I'). Okubo (1980b) illustrated only a female specimen of *Dolerocypria mukaishimensis* since male specimens could not be found. This species resembles *D. taalensis* (Tressler, 1937) which was redescribed by Wouters (1987), but the number of terminal claws of the antenna and the male copulatory organ are distinct (there are no processes on the male copulatory organ in *D. taalensis*). The carapace outline is similar to these of *Propontocypris* species, but the number of segments in the antennule and the shape of the caudal rami (furcae) are distinctive. Some "*Propontocypris*" species from Japan, which were reported without soft parts, need to be checked concerning on these characters. "Cyprididae n. sp." of Ikeya and Hanai (1982) probably belongs to this species, certainly to the same genus; however, those authors described no details of the soft parts.

Perissocytheridea? japonica Ishizaki, 1968
(Fig. 2K–N)

Clithrocytheridea sp. A: Ishizaki, 1968: 18, pl. 3, fig. 12.
Perissocytheridea japonica Ishizaki, 1968: 18, pl. 1, fig. 4, pl. 3, figs 4, 5; Hou *et al.* 1982, pl. 71, figs 19, 20, pl. 73, figs 9–13, text-fig. 25a, b; Okubo 1983: 403–409, figs 1–3; Ikeya *et al.* 1985, pl. 2, figs 4, 5, 7, 8; Wang, P.-X. *et al.* 1988: 236, pl. 38, figs 7, 8; Ikeya and Itoh 1991, fig. 20D; Yamane 1998, pl. 9, fig. 3.

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right lateral view (SUM-CO-1112); L, male carapace in external left lateral view (SUM-CO-1113); M, female carapace in right lateral view (SUM-CO-1114); N, female carapace in left lateral view (SUM-CO-1115). Scale bar = 350 μm for A–I, 75μm for J.

Fig. 3. *Dolerocypria mukaishimensis*. A, internal view of female RV; B, antennule of male; C, antenna of male; D, antenna of female; E, mandible; C'–E', enlarged details of C–E, respectively. A, SUM-CO-1109 (female); B, C, and E, SUM-CO-1110 (male); D, SUM-CO-1111 (female). Scale bar 1=200 μm for A. Scale bar 2=50 μm for B–E, 20 μm for B'–E'.

Fig. 4. *Dolerocypria mukaishimensis*. A, maxillule; B, fifth limb; C, walking leg; D, cleaning limb; E, male copulatory organ; F, female copulatory organ; G, furca; H, Zenker's organ; I, unknown organ; A', B', F', and I', enlarged details of A, B, F, and I, respectively; ca, copulatory apparatus; cd, copulatory duct; dl, distal lobe. A–E and G–I, SUM-CO-1110 (male); F, SUM-CO-1111 (female). Scale bar=50 μm for A–D and G–I, 20 μm for A', B', and I', 57 μm for F, 23 μm for E and F'.

Clithrocytheridea? japonica: Hanai *et al.* 1977: 24.

Diagnosis. Conspicuous sexual dimorphism in carapace lateral outline, elongate sub-trapezoidal and sub-triangular in male and female, respectively. Caudal process well developed. Carapace surface covered with striking reticulations. A few deep fossae in each reticular unit. Reticular muri parallel to outline in marginal zone.

Remarks. This species contrasts with *Perissocytheridea matosoni* (Stephenson, 1935), the type species of the genus *Perissocytheridea* proposed by Stephenson (1938), in carapace outline and ornamentation. Hanai *et al.* (1977) suggested that this taxon should represent a new genus.

Pontocythere miurensis (Hanai, 1959)
(Fig. 5A–D)

Cushmanidea miurensis Hanai, 1959: 299, pl. 16, figs 7–10, text-fig. 1a, b; 1961a, text-fig. 4A (1a, b).
Pontocythere miurensis: Hanai *et al.* 1977: 25; Wakamatsu 1988, pl. 34, figs 7–9.
Cushmanidea subjaponica: Okubo 1977: 133–140, figs 2, 3. [*nec* Hanai, 1959]
Pontocythere subjaponica: Kamiya and Nakagawa 1993, pl. 1, figs 7, 8; Irizuki *et al.* 1998, fig. 2 (1). [*nec* Hanai, 1959]

Diagnosis. Sub-crescentic carapace outline in lateral view, highest in middle. Female higher and shorter than male. Anterior margin gently tapering off. Moderate caudal process in lower half of posterior margin, relatively larger in right valve. Carapace surface smooth. Some very inconspicuous muri parallel to anterior margin. Narrow and weak fossae in mid-ventral margin of male. In male copulatory organ (not figured), capsule sub-square, distal lobe (=supporting lobe) elongate and curved. Copulatory duct coiling. Two 'claspers'; one stout and ∫-shaped, extending ventrally with small process in middle, other thin and elongated dorsally.

Remarks. There is considerable confusion in the identification of the species of this genus from Japan because all have similar ornamentation patterns on the

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Fig. 5. *Pontocythere miurensis* (Hanai, 1957) (A–D) and *Pontocythere xiphoidea* n. sp. (E–Q). A, male carapace in external right lateral view (SUM-CO-1116); B, male carapace in external left lateral view (SUM-CO-1117); C, female carapace in external lateral view (SUM-CO-1118); D, female carapace in external lateral view (SUM-CO-1119); E, male carapace in external right lateral view (holotype, SUM-CO-1120); F, male carapace in external left lateral view (paratype, SUM-CO-1121); G, H, female RV and LV in external lateral view (paratype, SUM-CO-1122); I, male carapace in external dorsal view (paratype, SUM-CO-1123); J, female carapace in external dorsal view (paratype, SUM-CO-1124); K, L, male LV and RV in internal lateral view (paratype, SUM-CO-1125); M, female LV in internal lateral view (paratype, SUM-CO-1126); N, female RV in internal lateral view (paratype, SUM-CO-1127); O, muscle scars of male RV (paratype, SUM-CO-1125); P, Q, hingement of female RV (paratype, SUM-CO-1127), anterior and posterior hinge areas. Scale bar=250 μm for A–C, 170 μm for E–N, 30 μm for O, 28 μm for P and Q.


A
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carapace. The authors have examined the holotypes of *Pontocythere japonica* (Hanai, 1959), *P. kashiwarensis* (Hanai, 1959), *P. miurensis*, and *P. subjaponica* (Hanai, 1959) by SEM. The specimens from the Obitsu River Estuary are smaller than the holotype of *P. miurensis* but the outline and the distributional pattern of pore-systems are identical with those of that species. The photographs and drawings of Okubo (1977), Kamiya and Nakagawa (1993), and Irizuki *et al.* (1998) are detailed enough to confirm the specimens described in those texts as conspecific with *P. miurensis*; most other listings, however, do not provide sufficient anatomical information to allow us to reach a determination with confidence.

Pontocythere xiphoidea n. sp.
(Figs 5E–Q, 6)

Pontocythere japonica: Yamane 1998, pl. 9, fig. 7. [*nec* Hanai, 1959]

Types. Holotype, SUM-CO-1120 (complete male carapace, length: 0.546 mm, height: 0.209 mm, width: 0.183 mm); paratypes, SUM-CO-1121 (complete male carapace), SUM-CO-1122 (LV and RV of female), SUN-CO-1123 (complete male carapace), SUM-CO-1124 (complete female carapace), SUM-CO-1125 (RV and LV of female), SUM-CO-1126 (LV of female), SUM-CO-1127 (RV of female), SUM-CO-1128 (RV, LV, and soft parts of male), SUM-CO-1129 (RV, LV, and soft parts of female), SUM-CO-1130 (RV, LV, and soft parts of male), and SUM-CO-1131 (RV, LV, and soft parts of female).

Etymology. Greek *xiphoeides* (xiphoid, meaning sword-shaped), referring to the male carapace form.

Type locality. Loc. 6: 1000 m off beach ridge on sand flat, at mouth of Obitsu River, Kisarazu City, Chiba Prefecture, Japan (35°25.7′N, 139°53.4′E), water depth *ca* 10 cm at lowest low tide.

Diagnosis. Carapace subcrescentic in lateral view, highest in middle (Fig. 5E–H). Female higher and shorter than male. Anterior margin gently tapering off. Caudal process produced from ventral half of posterior margin, with 1 denticle-tubercle each at upper and lower corners. Ventral margin concave medially. Carapace surface smooth. Several muri running parallel to anterior and posterior margins, with progressive increase in development anteriorly. Weak fossae also evident mid-ventrally. In male copulatory organ (Fig. 6J), capsule subquadrate, distal lobe (=supporting lobe) triangular. Copulatory duct long and stout; tip bent and swollen, with pointed end bearing long, filiform seta. One clasping apparatus bending and twisting around copulatory duct.

Description. Carapace outline elongate and slim in lateral view. Male carapace longer than that of female; sexual dimorphism of carapace relatively small. Anterior margin slightly irregular. Along antero-ventral margin, several gentle muri developed in parallel. Hingement (Fig. 5P, Q): antimerodont; on RV, 1 elongate tooth in anterior element; groove in median element; 3 or 4 fine teeth in posterior element. Muscle scars (Figs 5O, 6A, B): frontal scar elongate; mandibular scar ovate; upper-most 1 of 4 adductor scars separated from other 3; ventral scar below, between mandibular scar and lower-most adductor scar. Vestibules developed in anterior and posterior parts. Antennule (Fig. 6C): 5 articulated segments; 5th seg-

Fig. 6. *Pontocythere xiphoidea* n. sp. A, internal view of male RV; B, internal view of female RV; C, antennule; D, antenna; E, mandible; F, maxillule; G, first thoracic leg; H, second thoracic leg; I, third thoracic leg; J, copulatory organ of male; K, brush-shaped organ; E', F', and K', enlarged details of E, F, and K, respectively; ca, clasping apparatus; cd, copulatory duct; dl, distal lobe. A, SUM-CO-1128 (paratype, male); B, SUM-CO-1129 (paratype, female); C–J, L–R, SUM-CO-1130 (paratype, male); K, SUM-CO-1131 (paratype, male). Scale bar 1=100 μm for A and B. Scale bar 2=50 μm for C–K, 20 μm for E', F', and K'.

ment bearing 1 straight, 1 spatula-like, and 1 claw-like setae. Antenna (Fig. 6D): 4 articulated segments; 3rd segment bearing 2 stout and 1 thin setae at distal end; 4th segment bearing 1 stout, claw-like seta and 5 short setae at distal end. Mandible (Fig. 6E, E'): 5 articulated segments; coxa (basal segment) bearing well developed teeth at anterior end and 1 plumose seta on anterior distal margin; basis (2nd segment) bearing exopodite reduced to simple short seta, and 1 simple short seta at distal-ventral end; 2nd and 3rd segments of endopodite almost fused; 1st segment of endopodite bearing 4 long setae; 2nd segment bearing 5 long setae on ledge and 2 medium-long and short setae at distal end; 3rd (distal) segment bearing 3 simple setae and 1 plumose seta at distal end. Maxillule (Fig. 6F, F'): thin branchial plate with 15–16 plumose setae; basal podomere bearing 1 palp and 3 endites; palp with 8 setae, 3 endites bearing 6, 5, and 6 setae, respectively. Thoracic legs (Fig. 6G–I): all 3 legs 4-segmented; 1st thoracic leg smallest, terminating in short claw with short, fine hairs on distal half of anterior margin; 2nd leg medium-long and bearing long and thin claw-like setae with setules; 3rd leg largest and bearing long and stout claw-like seta with short, fine hairs.

Remarks. This species is similar to *P. subjaponica*, but the carapace outline in the male is slimmer than that of *P. subjaponica*. A distinctive difference from *P. subjaponica* is observed in the pore distributional pattern. Five additional pores compared with *P. subjaponica* are observed clearly in the posterior half of the carapace. This species tends to appear further offshore than *P. miurensis*.

Callistocythere pumila Hanai, 1957
(Fig. 7A, B)

Callistocythere pumila Hanai, 1957a: 459, 460, pl. 10, fig. 2a–c; Okubo 1975, fig. 1; Yamane 1998, pl. 3, fig. 5; Tsukagoshi 1998, pls 1–4, text-figs 1, 2; Irizuki and Hosoyama 2000, fig. 3 (3).

Callistocythere laevis Okubo, 1979, pl. 2, figs e–h, text-fig. 5. [Synonymized by Tsukagoshi 1998]

Diagnosis. Conspicuous sexual dimorphism in carapace ornamentation: female with numerous deep fossae on whole carapace except for noticeable flat tubercle in antero-dorsal area, irregular undulating ridges in posterior half, and 2 strong, parallel, marginal ridges anteriorly; male with weakly developed ornamentation in median area, 2 strong marginal ridges and a few fossae anteriorly, and numerous fossae and a few marginal ridges posteriorly. In male copulatory organ, copulatory duct coiling several times, glans located centrally within coil. Two large, curved claspers present, outer one larger. Thin, subtriangular, supporting lobe occurring distally.

Remarks. The carapace morphology of this species occupies an intermediate position between two genera of *Leptocythere* and *Callistocythere*; the male and female forms correspond to the former and the latter, respectively. Because of the large differences between sexes, the female and male individuals were separately described as different species by Okubo (1975 and 1979, respectively); thus, *Callistocythere laevis* Okubo, 1979 is a junior synonym of *C. pumila*. The number and size of the fossae on the carapace vary in the male.

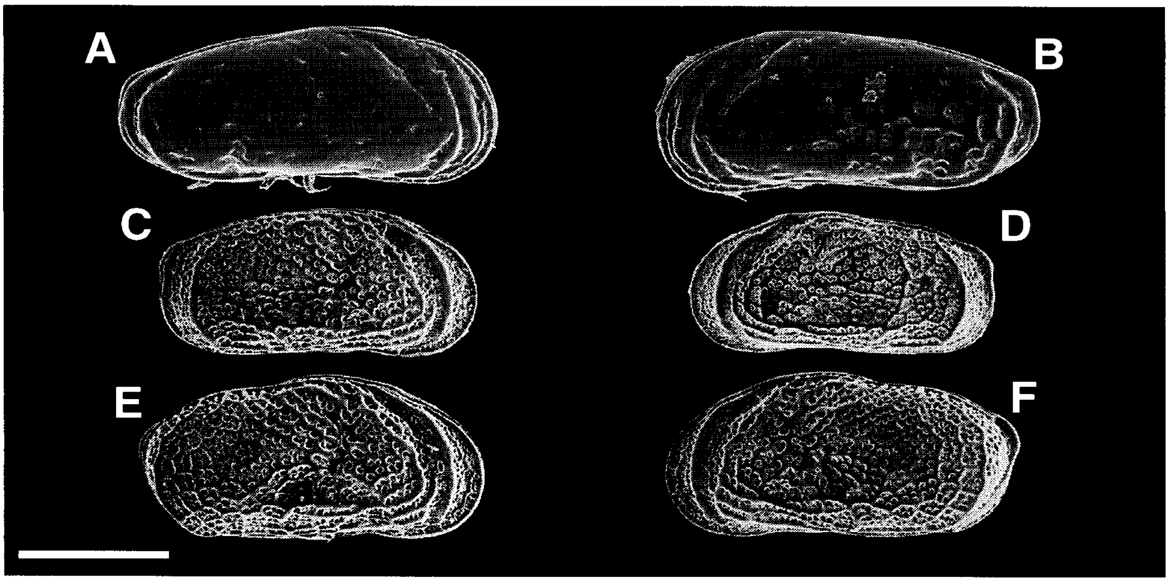


Fig. 7. *Callistocythere pumila* Hanai, 1957 (A, B) and *Ishizakiella miurensis* (Hanai, 1957) (C–F). A, male carapace in external right lateral view (SUM-CO-1132); B, male carapace in external left lateral view (SUM-CO-1133); C, male carapace in external right lateral view (SUM-CO-1134); D, male carapace in external left lateral view (SUM-CO-1135); E, female carapace in external right lateral view (SUM-CO-1136); F, female carapace in external left lateral view (SUM-CO-1137). Scale bar=200 μm for A and B, 300 μm for C–F.

Ishizakiella miurensis (Hanai, 1957)
(Fig. 7C–F)

Tanella miurensis Hanai, 1957a: 462, 463, pl. 9, fig. 1a–e, text-fig. 2I, J.
Tanella pacifica Hanai, 1957a: 465 (new name for *Cythere inflata* Brady, 1890 preoccupied); 1961a, text-fig. 10(5); Hanai *et al.* 1977: 34; Frydl 1982, listed in table 1.
Ishizakiella pacifica: Tsukagoshi 1992: 5, figs a–g.
Ishizakiella miurensis: Tsukagoshi 1994: 303, figs 3, 7B, 8A–I, 9, 12B; Tsukagoshi and Kamiya 1996, fig. 17A–D; Yamaguchi 2000, figs 2A, B, 8C, D.

Diagnosis. Carapace covered with coarse reticulations and strong, sub-peripheral ridges anteriorly and posteriorly. Male copulatory organ bearing 2 rounded and pointed claspers. Additionally, male copulatory organ with striking serrature on middle of copulatory duct.

Remarks. Species of the genus *Ishizakiella* in Japan were described in detail by Tsukagoshi (1994). Yamaguchi (2000) examined mtDNA to determine the relationships among populations of these species and presumed their course of migration. For the transition of the scientific name of this species, see Tsukagoshi (1994).

Genus ***Palusleptocythere*** n. gen.

Type species. *Palusleptocythere migrans* n. sp. in this paper.
Etymology. Latin *palus*=marsh.

Diagnosis. Carapace thin and smooth medially and especially dorsally. In lateral outline, bean-like in shape. Length/height ratio low. Duplicature making narrow vestibule. Marginal pore canals simple and straight, in contrast to more complex, branched forms found in other leptocytherid species. Weak hingement similar to that of juveniles of *Leptocythere* species.

Remarks. The carapace morphology is different from that of other leptocytherid adults, but similar to that of juveniles of other leptocytherid genera. The soft parts, however, show the characteristic adult features of this family. Dr. David J. Horne (pers. comm.) pointed out that this genus has "juvenile" carapace features, but that the appendages are typical of adult *Leptocythere* and/or *Callistocythere* and that the genus *Cluthia* is an example of a leptocytherid genus with juvenile features in both valves and appendages. In Japan and adjacent areas, three extant leptocytherid genera occur, *viz*, *Callistocythere*, *Leptocythere*, and *Ishizakiella*. We have been unable to determine the phylogenetic relationships between those taxa and the new genus. Although a few species of *Leptocythere* without branching (polyfurcate) marginal pore canals are known from freshwater environments in Europe (e.g., Petkovski and Keyser 1992), the new species described below can be easily discriminated from members of this genus (the type species of which is *Leptocythere pellucida* (Baird, 1850) with the elongate carapace and well developed teeth of hingement). In the authors' opinion, these differences warrant the proposal of a new genus.

Palusleptocythere migrans n. sp.
(Figs 8, 9)

Types. Holotype, SUM-CO-1138 (complete male carapace, length: 0.401 mm, height: 0.240 mm, width: 0.157 mm); paratypes, SUM-CO-1139 (complete male carapace), SUM-CO-1140 (complete female carapace), SUM-CO-1142 (complete female carapace), SUM-CO-1142 (complete male carapace), SUM-CO-1143 (complete female carapace), SUM-CO-1144 (RV and LV of male), SUM-CO-1145 (RV and LV of male), SUM-CO-1146 (RV and LV of female), SUM-CO-1147 (soft parts of male).

Etymology. Latin *migrans* (migrant), alluding to change of its habitat in the field area studied.

Type locality. Loc. B: small creek with associated flora of halophilous grass, at mouth of Obitsu River, Kisarazu-City, Chiba Prefecture, Japan (35°24.6′N, 139°54.2′E), muddy sand bottom, water depth *ca* 5 cm at lowest low tide.

Diagnosis. In lateral view, highest point of carapace at two-fifths from anterior end (Fig. 8A–D). Carapace surface weakly ornamented except for scattered fine pits and muri at or near anterior, ventral, and posterior margins. In male copulatory organ (Fig. 9J), distal lobe forming right triangle. Two clasping apparatuses present, one straight and narrowing distally, other one cigar-like with irregular inner margin. Copulatory duct coiling a few times, and glans narrowing at outside of coil.

Description. Sexual dimorphism present but not pronounced, female longer and higher than male. Hingement (Fig. 8I–L): modified amphidont; in RV, anterior element bearing 2 to 3 teeth, median element forming smooth bar, posterior element with 5 teeth; these teeth interlocking with corresponding sockets of LV; snap

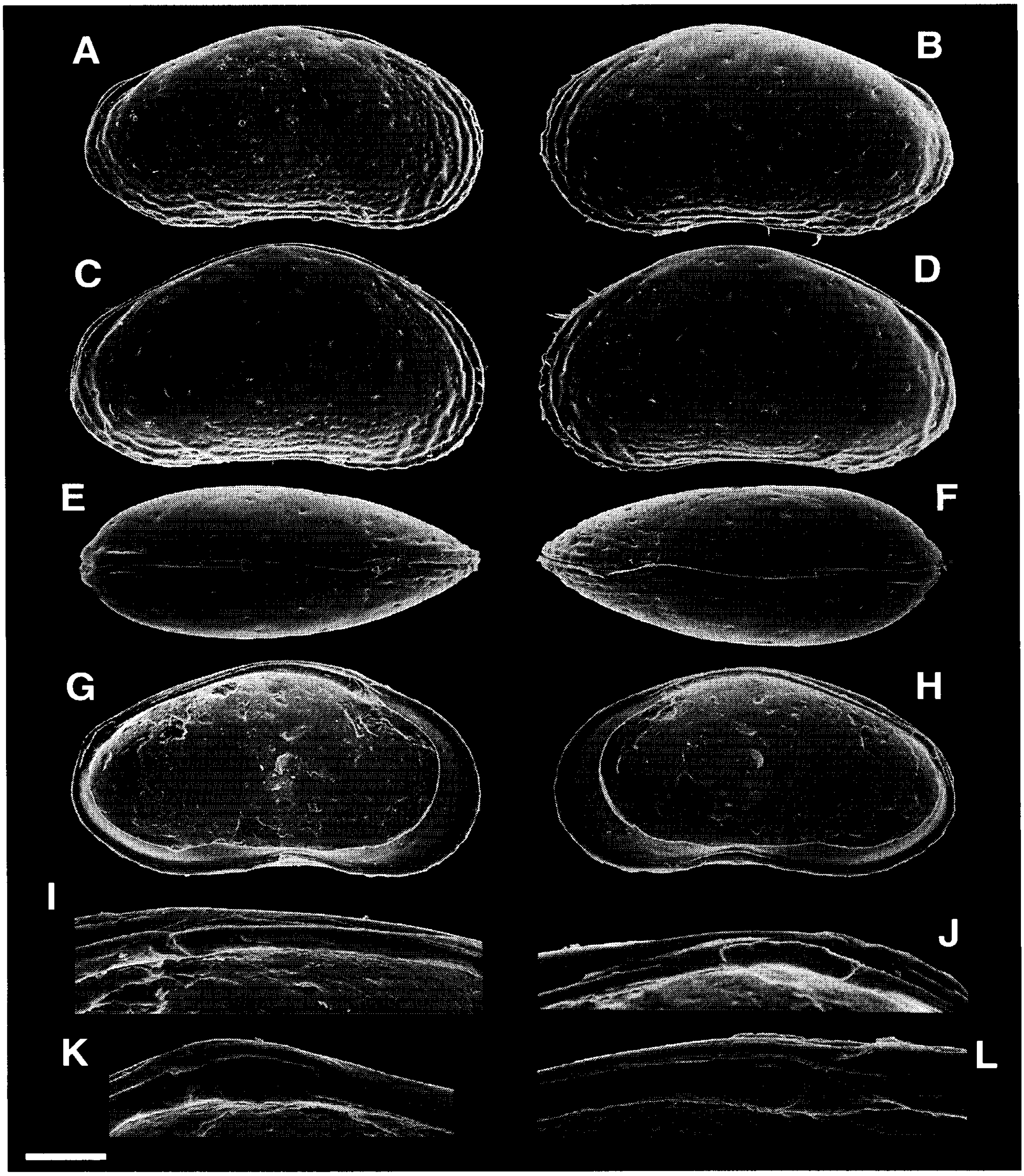


Fig. 8. *Palusleptocythere migrans* n. sp. A, male carapace in external right lateral view (holotype, SUM-CO-1138); B, male carapace in external left lateral view (paratype, SUM-CO-1139); C, female carapace in external right lateral view (paratype, SUM-CO-1140); D, female carapace in external left lateral view (paratype, SUM-CO-1141); E, male carapace in external dorsal view (paratype, SUM-CO-1142); F, male carapace in external dorsal view (paratype, SUM-CO-1143); G, H, male LV and RV in internal lateral view (paratype, SUM-CO-1144); I, J, anterior and posterior elements of hingement on male RV (paratype, SUM-CO-1144); K, L, posterior and anterior elements of hingement on male LV (paratype, SUM-CO-1144). Scale bar=100 μm for A–H, 20 μm for I–L.

Fig. 9. *Palusleptocythere migrans* n. sp. A, internal view of male RV; B, internal view of female RV; C, antennule; D, antenna; E, mandible; F, maxillule; G, first thoracic leg; H, second thoracic leg; I, third thoracic leg; J, male copulatory organ; C', E', and F', enlarged details of C, E, and F, respectively. A, SUM-CO-1145 (paratype, male); B, SUM-CO-1146 (paratype, female); C–J, SUM-CO-1147 (paratype, male). Scale bar=100 μm for A and B, 50 μm for C–H, 20 μm for C', E', and F', 25 μm for J.

structure present in middle ventral region inside carapace, mid-ventral snap of RV interlocking with corresponding socket of LV. Muscle scars (Fig. 9A, B): row of 4 adductor scars nearly vertical at inside of median to ventro-median of carapace; uppermost and lowermost scars oval, whereas middle 2 scars narrow with hollows in middle; J-shaped frontal scar present in front of upper 2 adductor scars; mandibular scar unclear. Antennule (Fig. 9C, C'): 5 articulated segments; distal end of 5th segment bearing seta, bristle, and claw-like seta with short and long setules. Antenna (Fig. 9D): 4 articulated segments; distal end of 3rd segment bearing feathery seta and claw-like seta with short, fine hairs on distal half of anterior margin; distal end of 4th segment bearing claw-like seta with short, fine hairs on distal half of anterior margin. Mandible (Fig. 9E, E'): 5 segments; coxa bearing teeth at anterior end and 2 short setae on anterior distal margin; distal-ventral end of basis bearing short seta and exopodite as 1 branched seta; distal end of 1st endopodal segment bearing 2 short setae and 2 long setae with long hairs at their distal ends; 2nd endopodal segment bearing 3 plumose setae, 1 stout seta, 1 short seta with short hairs at its root, and 1 long, stout seta with long hairs; 5th segment bearing 2 stout setae and 1 claw-like seta with stout root. Maxillule (Fig. 9F, F'): thin branchial plate with 16 setae; basal podomere bearing 1 palp and 3 endites; palp with 2 plumose setae, 3 simple setae, and 1 seta with 1 branch; 3 endites bearing several setae. Thoracic legs (Fig. 9G–I): all 3 legs 4-segmented; all legs terminating in claw-like setae with serrated fine hairs along distal and proximal parts of anterior margin.

Remarks. At present time, the new genus *Palusleptocythere* consists of only this species. But estuarine investigations of ostracods in Japan and adjacent areas have just begun. The occurrence of closely related species is expected in the future.

Spinileberis pulchra Chen in Hou *et al.*, 1982
(Figs 10, 11A–D)

Spinileberis pulchra Chen in Hou *et al.*, 1982: 239–240, pl. 86, figs 20–22; Ikeya *et al.* 1995, figs 7Sp, 8Sp; Wang, Hong and Zhao 1985, pl. 30, fig. 18; Wang, P.-X. *et al.* 1988: 235, pl. 38, fig. 4; Tanaka *et al.* 1998, pl. 1, fig. 1.

Diagnosis. Carapace outline and longitudinal ridges as in *S. quadriaculeata* (Brady, 1880) (Fig. 11A–D). Ornamental reticulation lacking in vicinity of sulci, in space between central and bottom ridges, and in anterior and posterior areas. No spines on posterior ends of central and bottom ridges. Long and fine coil-shaped structure in center of capsule of male copulatory organ (Fig. 10J). Tip of distal lobe pointed ventrally. Copulatory duct short and coiling once.

Description. Antennule (Fig. 10C): 5 articulated segments; 5th segment bearing 2 long, supple setae and 1 claw-like seta with serrations arranged in 2 rows along its anterior margin. Antenna (Fig. 10D): 4 articulated segments; 4th segment bearing 2 claw-like setae at posterior middle margin and 1 claw-like seta at distal end; distal seta with row of serrations. Mandible (Fig. 10E, E'): 4 segments; coxa (basal segment) bearing teeth along anterior margin and short plumose seta on anterior margin; basis (2nd segment) bearing exopodite reduced to feathery seta, 1 long seta with short, fine hairs, and small branchial plate on ventral margin; seg-

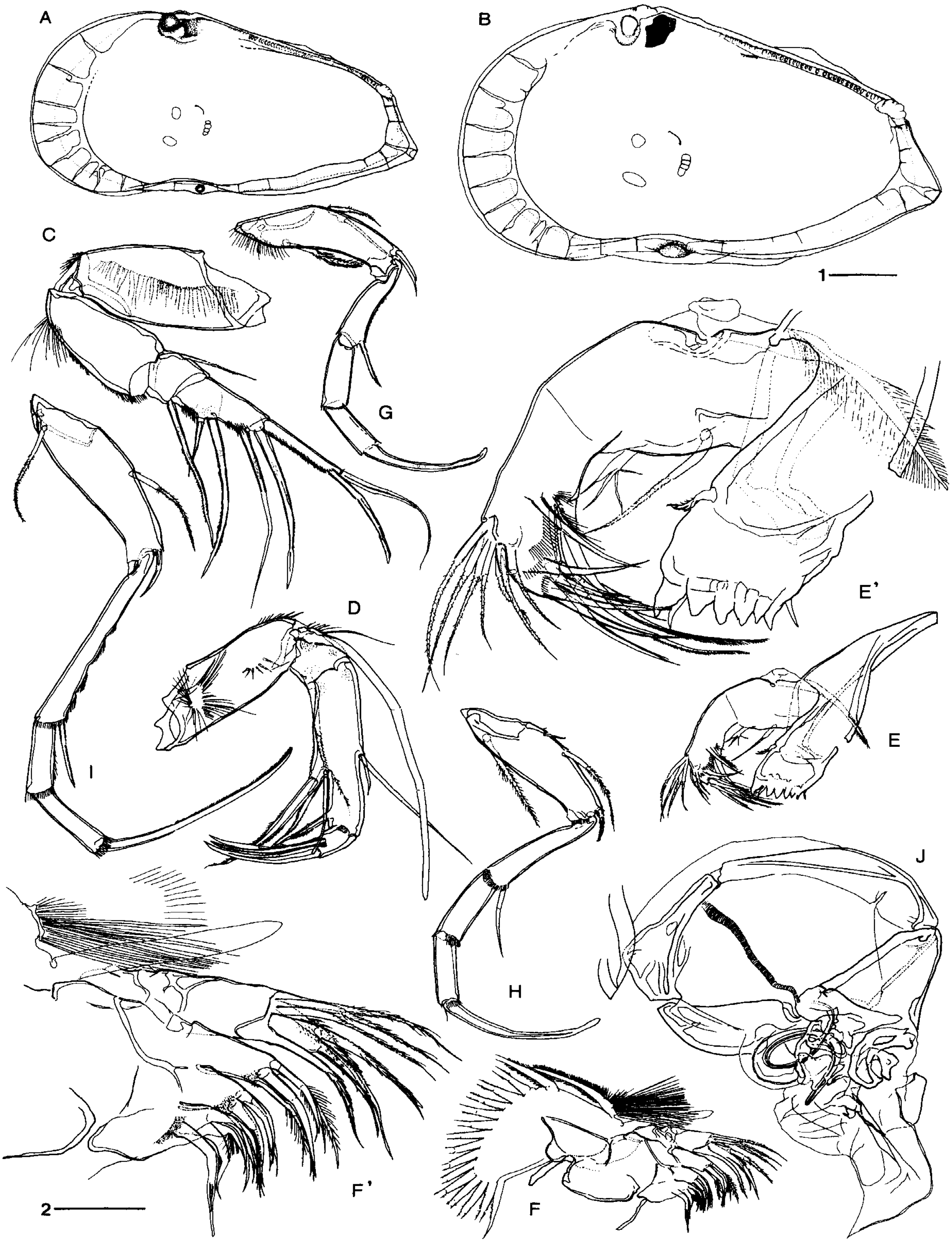


Fig. 10. *Spinileberis pulchra* Chen, 1982. A, internal view of male RV; B, internal view of female RV; C, antennule; D, antenna; E, mandible; F, maxillule; G, first thoracic leg; H, second thoracic leg; I, third thoracic leg; J, male copulatory organ; E' and F', enlarged details of E and F, respectively. A, SUM-CO-1151 (male); B, SUM-CO-1152 (female); C–J, SUM-CO-1153 (male). Scale bar 1=100 μm for A and B. Scale bar 2=50 μm for C–J, 20 μm for E' and F'.

ments of endopodite almost fused; 7 plumose setae on anterior middle margin of endopodite; 2 long distal setae, each with row of short hairs, short seta with row of serrations, and short seta with long hairs present on posterior middle margin of endopodite; 7 stout setae and 3 setae distally on endopodite. Maxillule (Fig. 10F, F'): thin branchial plate with 16 plumose setae, 1 blunt seta, and bundle of long hairs; basal podomere bearing palp and 3 endites, palp with 8 setae, endites each bearing several plumose and simple setae. Thoracic legs (Fig. 10G–I): all 3 legs 4-segmented and similar in shape; long seta at distal end of third legs bearing row of short hairs along distal half of anterior margin.

Remarks. This species was proposed as new in Hou *et al.* (1982) but the author of the new species was specified therein as T.–C. Chen. The chitinous appendages of this species are illustrated in this paper for the first time. They are very similar to those of *S. quadriaculeata* except for the coil-shaped structure within the male copulatory organ and the length of the copulatory duct.

Spinileberis quadriaculeata (Brady, 1880)
(Fig. 11E, F)

Cythere quadriaculeata Brady, 1880: 86, 87, pl. 25, fig. 4a–d.
Spinileberis quadriaculeata: Hanai 1961b: 167–170, figs 1–7; Ishizaki 1968: 42, pl. 7, figs 15, 16; 1969: 222, pl. 26, fig. 18; 1971: 95–96, pl. 4, fig. 4; Ishizaki and Kato 1976: 140–141, text-fig. 9, pl. 4, figs 10, 11; Okubo 1978: 94–96, figs 1g–h, 3, 4i–n; Ikeya 1982, fig. 1865; Hou *et al.* 1982: 238–239, pl. 86, fig. 19; Ikeya 1983, fig. 1 (4–6); Ishizaki 1984, pl. 1 (12); Ikeya *et al.* 1985, pl. 3, figs 9, 10; Nohara and Tabuki 1985, pl. 2, fig. 13; Wang and Zhang 1987: 291, pl. 2, fig. 32a, b; Ikeya *et al.* 1987, pl. (2), fig. 8; Bodergat and Ikeya 1988: 421, text-fig. 4f; Ishizaki 1990, fig. 1 (2); Lee 1990: 214–215, pl. 12, fig. 9; Takayasu *et al.* 1990, fig. 5; Yajima and Lord 1990, fig. 5 (7); Ikeya and Itoh 1991: 145, fig. 24B; Huh 1992, pl. 1, figs 9, 10; Huh and Paik 1992, pl. 3, fig. 8; Ikeya 1993, fig. 3 (2A–E); Ikeya and Shiozaki 1993: 17, fig. 2 (3A–E); Kamiya and Nakagawa 1993, pl. 3, figs 2, 3; Tsukagoshi *et al.* 1994: 47–48, pl. 2/23, figs 1–6; Ikeya 1995: 31, fig. 3; Ikeya *et al.* 1995, figs 7Sq, 8Sq; Irizuki *et al.* 1998, fig. 2 (8); Tanaka *et al.* 1998, pl. 1, fig. 7; Yamane 1998, pl. 12, fig. 2; Irizuki *et al.* 1999, fig. 1 (B-1); Irizuki and Hosoyama 2000, fig. 3 (7).

Diagnosis. Carapace irregularly trapezoidal in lateral view. Hingeline almost straight. Dorsal margin of RV slightly arched and overlying left valve in right lateral view. Posterior margin triangular. Ventral margin concave in inner lateral view. Carapace surface ornamented with longitudinal ridges and reticulations. Dorsal ridge running along dorsal margin to upper half of anterior margin. Medial ridge running obliquely across center and terminating posteriorly in sharp spine. Bottom ridge running along ventral margin and forming sharp spine at posterior end. Reticulation developed except for anterior marginal area. Sulci in post-ocular and dorsomedian positions. "Snap structure" in center of inner ventral margin.

Remarks. The ecological relationships between three species of *Spinileberis*, *S. furuyaensis* Ishizaki and Kato, 1976, *S. pulchra*, and *S. quadriaculeata*, were investigated by Ikeya *et al.* (1995). In terms of habitat, the present species and *S. pulchra* inhabit the outermost and innermost zones, respectively, relative to the

shore.

Aurila disparata Okubo, 1980
(Fig. 11G, H)

Aurila disparata Okubo, 1980c: 402–403, figs 4, 7e, f, 9e–j; 1988, text-fig. 3 (part); Yamane 1998, pl. 2, fig. 1.

Diagnosis. Carapace surface covered with reticular fossae (these increasing in size towards carapace margins) and fine pits. Two radial ridges running anteriorly and 1 radial ridge running downwards posteriorly. Narrow dorsal ridge (swollen posteriorly) connecting to eye tubercle.

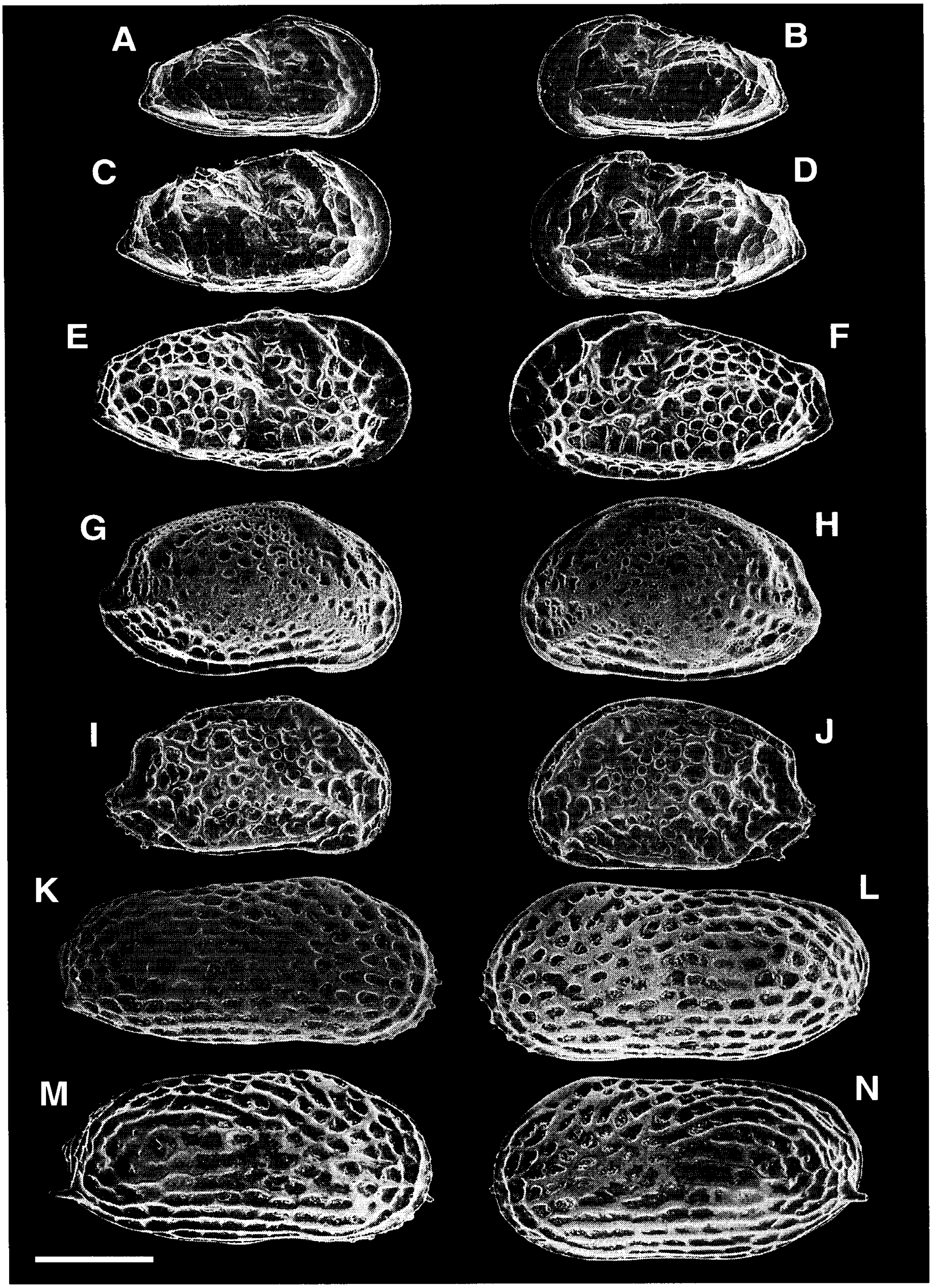
Remarks. Okubo (1980c) distinguished this species from other species of *Aurila* by the shape of the male copulatory organ. This species usually lives on algae on rocky shores. In the study area only one dead (presumably allochthonous) specimen was found, at Loc. 18.

Robustaurila ishizakii (Okubo, 1980)
(Fig. 11I, J)

Mutilus sp.: Hanai 1961a: 372–373, text-fig. 13–1a, b; Hiruta 1981: 17–18, fig. 8 (4).
Mutilus assimilus [*sic*]: Ishizaki 1971: 83, pl. 3, fig. 14; Hou *et al.* 1982: 178, pl. 75, figs 18–22; Zheng 1987: 197, pl. 4, figs 16–18. [*nec* Kajiyama, 1913]
Mutilus ishizakii Okubo, 1980c: 405–408, figs 6a–i, 7c, 7d, 11e–g.
Robustaurila assimilis: Yajima 1982: 212, pl. 13, figs 6–8. [*nec* Kajiyama, 1913]
Mutilus assimilis: Ikeya 1982, fig. 1868a, b; Ikeya *et al.* 1985, pl. 4, figs 16, 17; Ishizaki and Matoba 1985, pl. 5, fig. 5; Wang, P.-X. *et al.* 1988: 253, pl. 47, figs 5, 6. [*nec* Kajiyama, 1913]
Aurila sp.: Paik and Lee 1988: 550, pl. 2, fig. 6.
Robustaurila ishizakii: Ikeya and Hamada 1990: 137–144, pl. 17 (138), figs 1–3, pl. 17 (140), figs 1–3, pl. 17 (142), figs 1–4, pl. 17 (140), figs 1–3, text-fig. 1a, b; Ikeya and Itoh 1991: 142, fig. 21C; Tsukagoshi *et al.* 1994: 49, pl. 2/25, figs 1–6.

Diagnosis. Carapace antero-dorsally arched, coarsely and irregularly reticulate with somewhat prominent radial ridges. Radial ridge to postero-dorsal corner highly sinuous, U-shaped. Postero-dorsal marginal spine absent. Postero-ventral

Fig. 11. *Spinileberis pulchra* Chen, 1982 (A–D), *S. quadriaculeata* (Brady, 1880) (E, F), *Aurila dispatara* Okubo, 1980 (G, H), *Robustaurila ishizakii* (Okubo, 1980) (I, J), and *Bicornucythere bisanensis* (Okubo, 1975) (K–N). A, male carapace in external right lateral view (SUM-CO-1148); B, male carapace in external left lateral view (SUM-CO-1149); C, D, female RV and LV in external lateral view (SUM-CO-1150); E, F, female RV and LV in external lateral view (SUM-CO-1154); G, H, RV and LV in external lateral view (SUM-CO-1155); I, J, RV and LV in external lateral view (SUM-CO-1156); K, L, male RV and LV in external view (SUM-CO-1157); M, N, female RV and LV in external view (SUM-CO-1158). Scale bar=300 μm for A–D and G–N, 200 μm for E and F.


A
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margin with several denticles. Ventro-lateral alae gently curved and with pronounced ridge terminating medially on caudal process. In dorsal view, marginal rim relatively narrow. Left valve somewhat higher than right.

Remarks. This species inhabits the algal zone of rocky shores (Ikeya and Hamada 1990). Only dead specimen was found in the present study area, at loc.5. The specimen is probably allochthonous.

Bicornucythere bisanensis (Okubo, 1975)
(Fig. 11K–N)

Cythere hodgii: Brady 1880: 94–95, pl. 25, fig. 1a–d. [*nec* Brady, 1866]
Cythereis hodgei [*sic*]: Kajiyama 1913: 13, pl. 1, figs 70, 71. [*nec* Brady, 1866]
Leguminocythereis hodgii: Ishizaki 1968: 25–26, pl. 5, figs 3, 4; 1969: 219, pl. 25, fig. 15, pl. 26, fig. 7; 1971: 84, pl. 3, figs 6, 7; 1972: 697–707, pl. 7, figs 1–13, pl. 8, figs 1–10. [*nec* Brady, 1866]
Leguminocythereis? hodgii: Ishizaki 1975: 245–249, pls 1, 2, text-fig. 2. [*nec* Brady, 1866]
Leguminocythereis bisanensis Okubo, 1975: 26–31, text-figs 2a–l, 3a–j; Ishizaki 1976, pl. 1.
Ruggieria (Keijella) bisanensis: Hanai *et al.* 1977: 52.
Keijella bisanensis: Abe 1983, pls 26, 27; Abe 1985, fig. 1 (only lower three), text-fig. 1; Wang and Zhang 1987, pl. 2, figs 15, 16; Wang, Q. *et al.* 1988, pl. 1, fig. 6.
Bicornucythere bisanensis: Schornikov and Shaitarov 1979: 45–47, pls 1, 2; Okada 1981, figs 1–3; Ikeya 1982, fig. 1876; Okada 1982a, figs 1–12; 1982b, text-figs 1–4, 6–11, 13–16, pls 16–30; Ishizaki 1984, pl. 1 (8); Ikeya *et al.* 1985, pl. 5, fig. 7; Ishizaki and Matoba 1985, pl. 2, fig. 5; Wang and Bian 1985, pl. 15, fig. 11; Wang, Min, and Yunhua 1985, pl. 11, fig. 17; Wang and Zhao 1985, pl. 7, fig. 17; Zhao *et al.* 1985, pl. 20, fig. 1; Ikeya *et al.* 1987, pl. (1), figs 12, 13; Bodergat and Ikeya 1988: 421, text-fig. 4c; Paik and Lee 1988, pl. 3, fig. 1; Wang, P.-X. *et al.* 1988: 251, pl. 45, figs 7–9; Zhao and Wang 1988, pl. 1, fig 10; Ishizaki 1990, fig. 1 (4); Takayasu *et al.* 1990, fig. 8; Yajima and Lord 1990, fig. 4 (3); Ikeya and Itoh 1991, fig. 12A; Ikeya 1993, fig. 3 (3A–E); Ikeya and Shiozaki 1993: 17, fig. 2 (3A–E); Ishizaki *et al.* 1993, fig. 7B; Kamiya and Nakagawa 1993, pl. 4, fig. 11; Kamiya *et al.* 1996, pl. 4, fig. 5; Ozawa 1996, pl. 2, fig. 2; Irizuki *et al.* 1998, fig. 3 (2); Tanaka *et al.* 1998, text-fig. 6, pl. 1, fig. 8; Yamane 1998, pl. 2, fig. 4; Fujiwara *et al.* 2000, fig. 3; Irizuki *et al.* 1999, fig. 1 (B-2); Irizuki and Hosoyama 2000, fig. 3 (13).

Diagnosis. Carapace outline rectangular-ovate in lateral view. Anterior margin evenly rounded and slightly depressed ventrally, with 3–8 marginal pore denticles on ventral half of that margin. Large posterior spine directed obliquely downward, without pore canal. Posterior produced to form modest caudal process. Strong reticular ornamentation present over most of carapace surface arranged in rows running subparallel to postero-dorsal, posterior, and ventral margins, and obliquely to dorsal and anterior margins over antero-dorsal third of carapace.

Remarks. Juveniles show morphological variation in carapace ornamentation (Ishizaki 1975; Abe 1983) and occasionally there are two or three branching spines on the posterior margin (Abe 1983). Only dead specimens (empty carapaces

or separated valves) were found in the present study area. They are probably allochthonous.

Angulicytherura? miii (Ishizaki, 1969)
(Figs 12, 13A–D)

Tetracytherura miii Ishizaki, 1969: 216–217, pl. 26, figs 10, 11, pl. 24, figs 1–3; 1971: 79, pl. 2, fig. 17.
Cytherura? miii: Hanai *et al.* 1977: 54; Kamiya and Nakagawa 1993, pl. 5, figs 5, 6; Yajima *et al.* 1985, pl. 1, figs 3, 6.
Cytherura miii: Takayasu *et al.* 1990, fig. 11; Tsukagoshi and Kamiya 1996: 361, fig. 13E–H.
Angulicytherura miii: Tsukagoshi and Parker 2000, fig. 5C, D

Diagnosis. Carapace surface with obvious reticulation pattern composed of long longitudinal carinae and short latitudinal muri (Figs 12A, B, 13A–D). Sexual dimorphism of carapace relatively great: male longer and higher in posterior half than female. In copulatory organ (Fig. 12J), basal capsule almost circular and distal lobe elongate with 3 clasping apparatuses: 2 of them relatively long and curved, with outer one stout and inner one thin; other 1 short, derived from base of distal lobe; long copulatory duct with single coil.

Description. Antennule (Fig. 12C): 6 articulated segments; 6th segment bearing long seta, stout seta with serrations, and long, stout seta with short, fine hairs in distal part; numerous hairs present on anterior margin from 2nd to 5th segments. Antenna (Fig. 12D): 5 articulated segments; spatula-like seta present at distal end of 3rd segment; 5th segment bearing 2 stout, claw-like setae distally. Mandible (Fig. 12E, E'): 6 segments; 1st to 3rd segments of endopodite almost fused; coxa bearing teeth, with short, plumose seta on anterior distal margin; basis bearing exopodite reduced to feathery long seta; 2 plumose setae, one of them bifid, at distal-ventral end of basis; 1st segment of endopodite bearing 3 plumose setae and long seta with numerous spines; 2nd segment bearing 2 plumose setae and 2 long simple setae at distal end; 3rd segment bearing simple seta and stout seta, latter with row of short hairs; 4th segment bearing 2 claw-like setae and slender seta at distal end. Maxillule (Fig. 12F, F'): thin branchial plate with 17 setae (1 of them extremely reduced); basal podomere bearing palp and 3 endites, palp with 8 setae including 1 with spatula-like end, endites bearing 6, 7, and 5 setae, respectively. Thoracic legs (Fig. 12G–H): 1st and 2nd thoracic legs 4-segmented and terminating in claw-like seta with short, fine hairs on distal part; 3rd leg 5-segmented and terminating in slender, claw-like seta with short, fine hairs on distal part.

Remarks. Genus *Angulicytherura* was proposed by Schornikov and Dolgov (1995). A spoon-like sense organ on the antenna, which is one of diagnostic features of the genus, was observed in the present specimens. This species appeared as living specimens only in the cold season, in January and March.

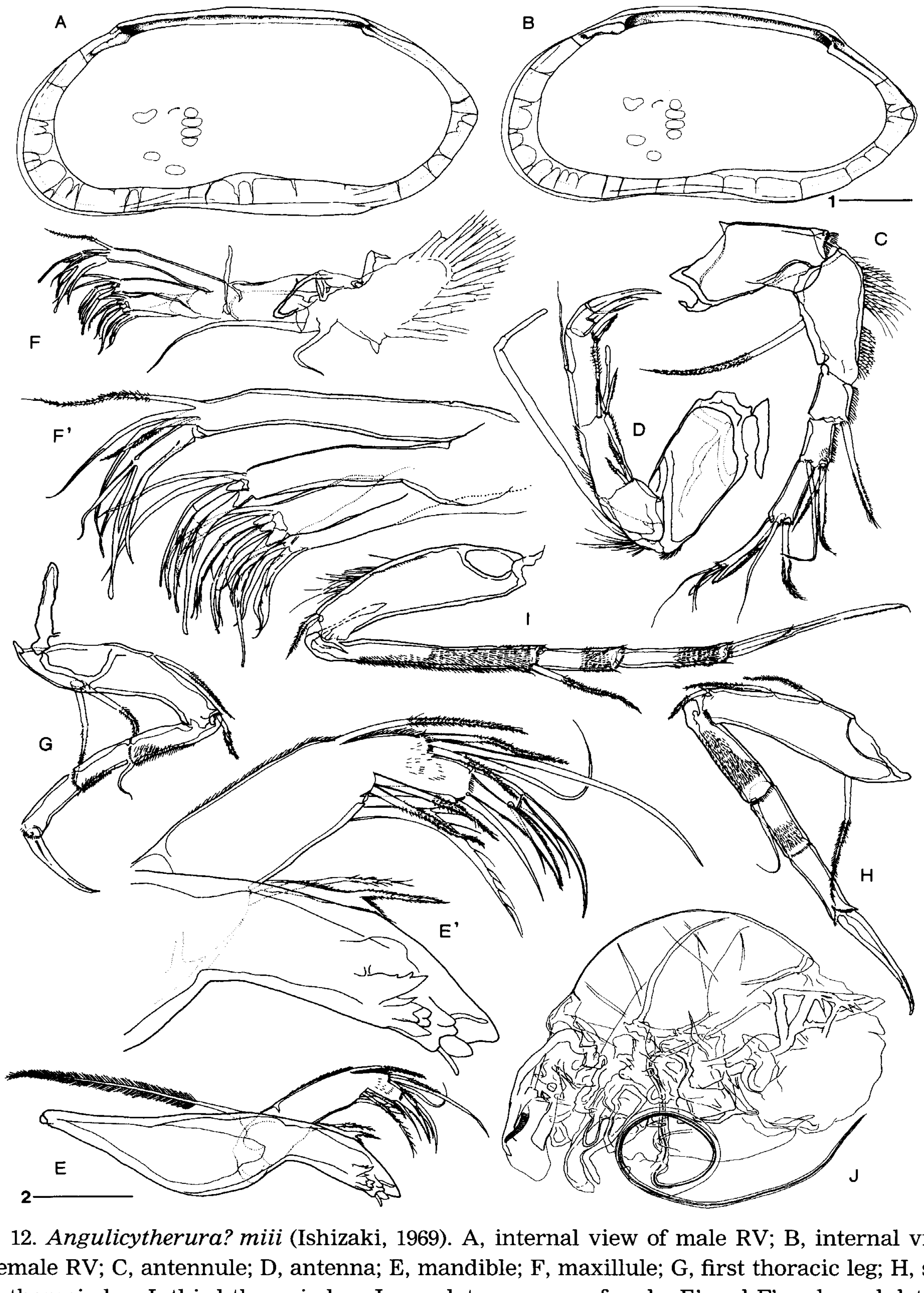

Fig. 12. *Angulicytherura? miii* (Ishizaki, 1969). A, internal view of male RV; B, internal view of female RV; C, antennule; D, antenna; E, mandible; F, maxillule; G, first thoracic leg; H, second thoracic leg; I, third thoracic leg; J, copulatory organ of male; E' and F', enlarged details of E and F, respectively. A, SUM-CO-1163 (male); B, SUM-CO-1164 (female); C, D, and F–J, SUM-CO-1165 (male); E, SUM-CO-1166 (male). Scale bar 1=100 μm for A and B, scale bar 2=50 μm for C–I, 20 μm for E' and F', 90 μm for J.

Hemicytherura tricarinata Hanai, 1957
(Fig. 13G, H)

Hemicytherura tricarinata Hanai, 1957b: 25–26, pl. 2, fig. 3a, b; Ishizaki 1968: 20, pl. 4, fig. 13; Okubo 1980a: 16–18, figs 1e, f, 2i–l, 6; Hou *et al.* 1982: 176–177, pl. 74, fig. 18, text-fig. 38a, b; Ikeya 1982, fig. 1881a, b; Ikeya *et al.* 1985, pl. 5, figs 17–19; Kamiya 1988, text-fig. 5 (10); 1989, fig. 4 (10); Yajima and Lord 1990, fig. 5 (8); Tsukagoshi *et al.* 1994: 49, pl. 2/27, figs 1–8; Yamane 1998, pl. 5, fig. 7; Irizuki and Hosoyama 2000, fig. 3 (14).

Diagnosis. Carapace small, thick, and elongate subrhomboidal, highest in lateral view approximately 1/3 from anterior end. Central latitudinal ridge branching to connect with 3 dorsalwards ridges and 2 ventralwards ridges. Marginal ridge continuous except around anterior margin. These ridges outlining several large reticulations. Caudal process well developed, especially on left valve.

Remarks. Only dead specimens (empty carapaces or separated valves) were found in the study area (Loc. 6). They are likely allochthonous.

Hemicytherura sp.
(Fig. 13E, F)

Hemicytherura kajiyamai: Okubo 1980a: 14–16, figs 1c, 1d, 2e–h, 5; Kamiya 1988, text-fig. 5 (9); 1989: 79, fig. 4 (9). [*nec* Hanai, 1957]
Hemicytherura sp. A: Lee 1990: 321–322, pl. 27, figs 3, 4.

Diagnosis. Small, thick and subrhomboidal carapace. Highest point in lateral view at middle. Anterior margin bearing 4 to 5 small spine-like processes on lower half. Postero-most end with well-developed caudal process. Three strong ridges running obliquely downwards in anterior half. Several large round fossae in center and posterior half. Large elongate fossae between ridges in anterior half. Most of fossae have some fine inner ridges.

Remarks. *Hemicytherura kajiyamai* Hanai, 1957 resembles this species but it is distinguished by having a strong ala at the postero-ventral end and by the pattern of fossae. Only dead specimens (carapaces without soft part or separated valves) were found in the study area (Loc. 18). They are likely allochthonous.

Semicytherura wakamurasaki Yajima, 1982
(Figs 13I–L, 14)

Semicytherura wakamurasaki Yajima, 1982: 218, 220, pl. 14, figs 1–8, 17, text-fig. 16-1, 2; Ikeya *et al.* 1985, pl. 6, figs 5, 6; Wang, P.-X. *et al.* 1988: 263, pl. 51, figs 11–16; Ikeya and Itoh 1991: 141, fig. 23C.
Semicytherura? miurensis: Ikeya 1982, fig. 1882b–d. [*nec* Hanai, 1957]

Diagnosis. Small-sized species within the genus. Dorsal margin of carapace arched and highest in lateral view at middle. Approximately 12 longitudinal ridges

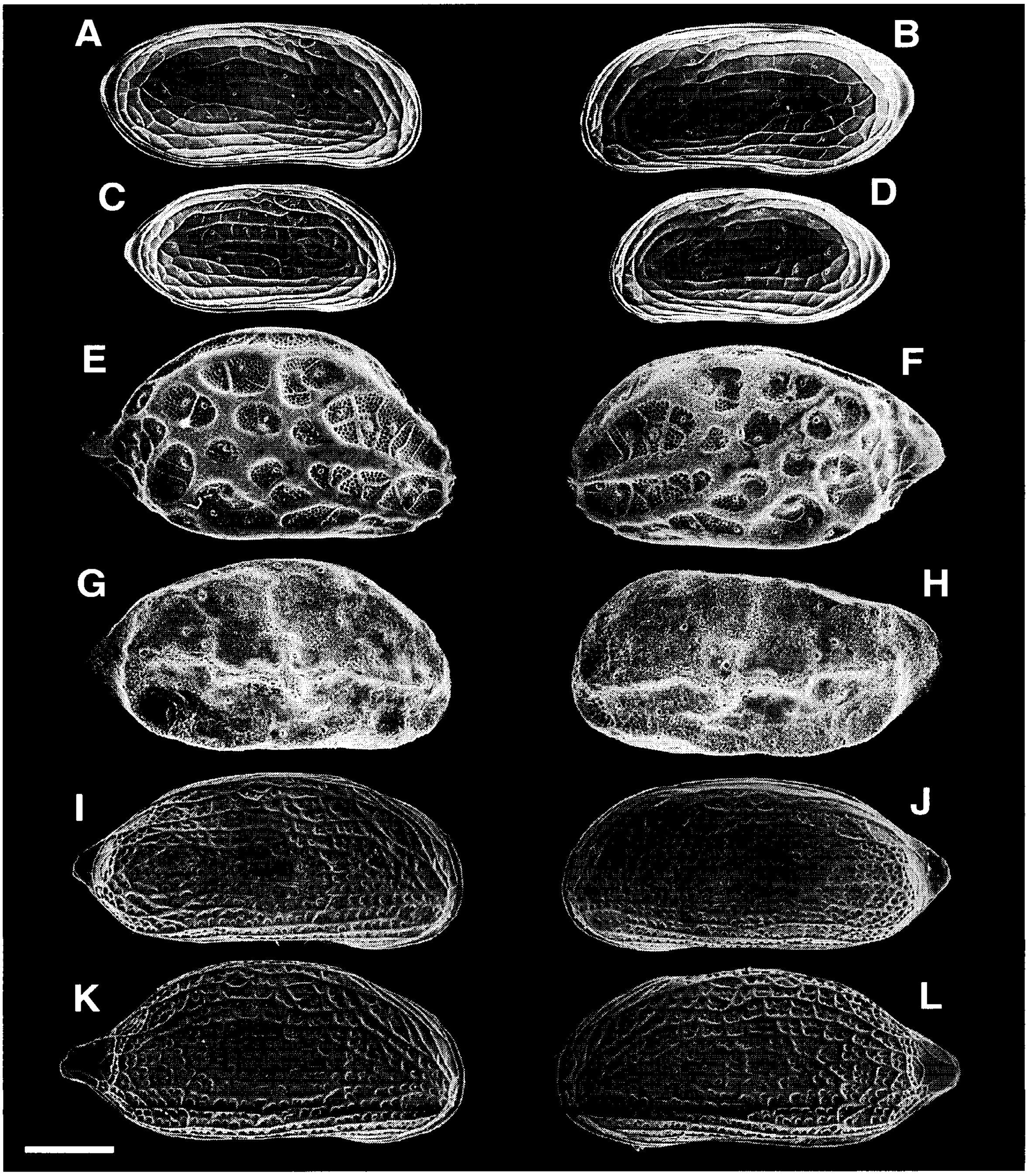

Fig. 13. *Angulicytherura? miii* (Ishizaki, 1969) (A–D), *Hemicytherura* sp. (E, F), *H. tricarinata* Hanai, 1957 (G, H), and *Semicytherura wakamurasaki* Yajima, 1982 (I–L). A, male carapace in external right lateral view (SUM-CO-1159); B, male carapace in external left lateral view (SUM-CO-1160); C, female carapace in external right lateral view (SUM-CO-1161); D, female carapace in external left lateral view (SUM-CO-1162); E, F, RV and LV in external lateral view (SUM-CO-1167); G, H, RV and LV in external lateral view (SUM-CO-1168); I, male RV in external lateral view (SUM-CO-1169); J, male carapace in external left lateral view (SUM-CO-1170); K, L, female RV and LV in external lateral view (SUM-CO-1171). Scale bar=200 μm for A–D, 100 μm for E–L.

Fig. 14. *Semicytherura wakamurasaki* Yajima, 1982. A, B, antennule; C, antenna; D, mandible; E, maxillule; F, first thoracic leg; G, second thoracic leg; H, third thoracic leg; I, copulatory organ of male; A', B', enlarged details of A, B, respectively. A–H, SUM-CO-1172 (male); I, SUM-CO-1173 (male). Scale bar=50 μm for A–C and F–H, 20 μm for A', B', D, and E, 40 μm for I.

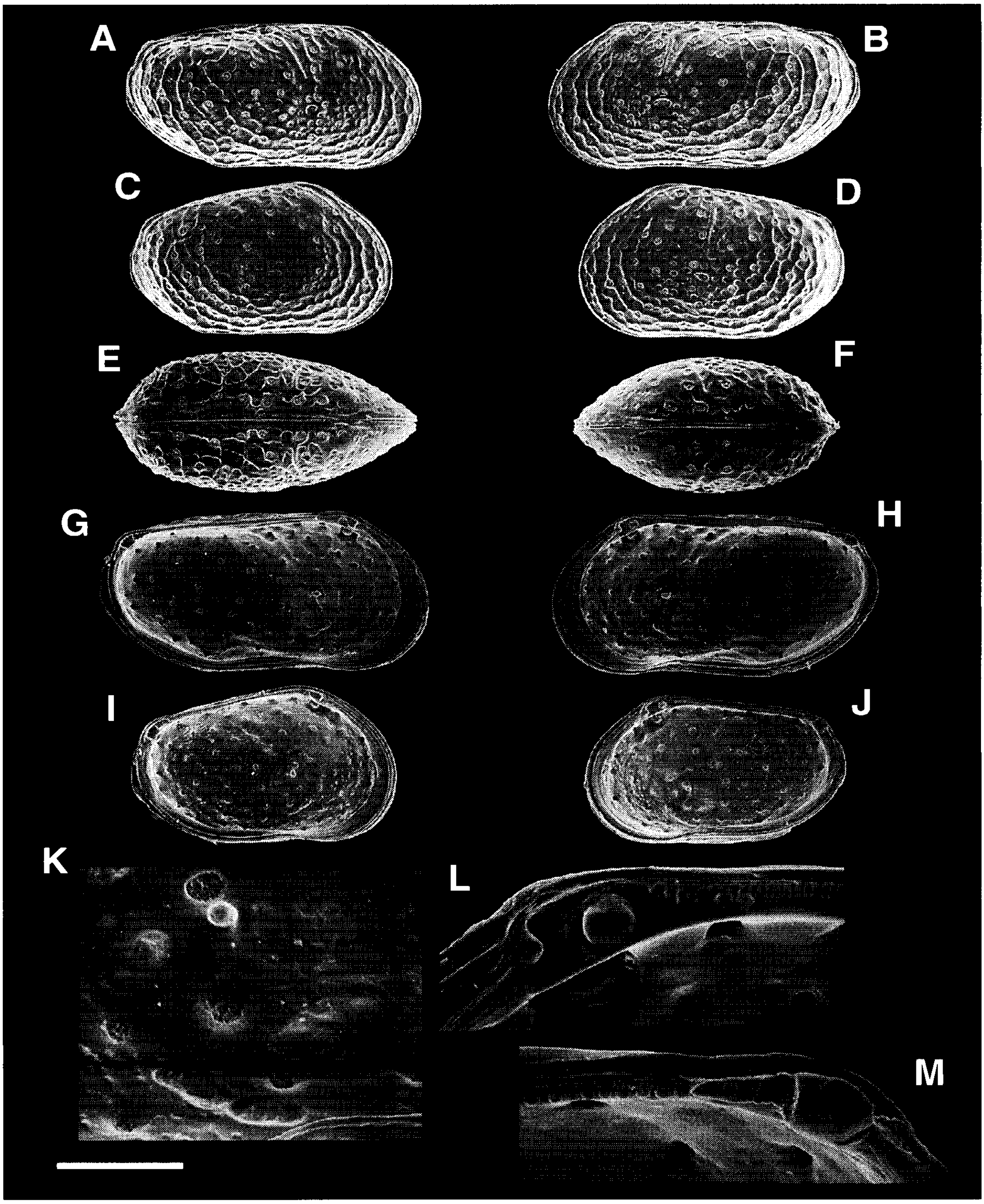

Fig. 15. *Loxoconcha kosugii* n. sp. A, male carapace in external right lateral view (holotype, SUM-CO-1174); B, male carapace in external left lateral view (paratype, SUM-CO-1175); C, female carapace in external right lateral view (paratype, SUM-CO-1176); D, female carapace in external left lateral view (paratype, SUM-CO-1177); E, male carapace in external dorsal view (paratype, SUM-CO-1178); F, female carapace in external dorsal view (paratype, SUM-CO-1179); G, male LV in internal lateral view (paratype, SUM-CO-1180); H, male right valve in internal lateral view (paratype, SUM-CO-1181); I, female left valve in internal lateral view

running parallel at midlength and converging anterior and posterior ends. Male copulatory organ with coiled copulatory duct and 2 clasping apparatuses, one large and L-shaped, other one small (Fig. 14I); distal lobe subtriangular with small, swollen-tipped process.

Description. Antennule (Fig. 14A, A', B, B'): 6 articulated segments; 6th segment bearing 2 long, simple setae and branched seta terminating in spatula-like ends and in rounded head, respectively (Fig. 14B'); 3rd segment bearing stout seta distally; 4th segment bearing 2 stout setae and long, fine seta distally; 5th segment bearing stout seta and 2 long, fine setae distally. Antenna (Fig. 14C): 4 articulated segments; 3rd segment bearing vestiges of articulation, with long seta on proximal part of anterior margin; 4th segment bearing 2 claw-like setae at distal end. Mandible (Fig. 14D): 5 segments; coxa bearing poorly developed teeth and with short process at anterior end; thin seta with hairs on anterior margin of coxa; basis bearing exopodite reduced to soft seta; distal segment of endopodite bearing 4 setae at distal end. Maxillule (Fig. 14E): thin branchial plate with 18–19 seta and bundle of hairs; basal podomere bearing palp and 3 endites, palp with 6 setae, endites bearing 6, 7, and 4 setae, respectively. Thoracic legs (Fig. 14F–H): all 3 legs 4-segmented; 1st and 2nd legs terminating in long, unguiform seta; 3rd one terminating in seta with hairs arranged like comb.

Remarks. The soft parts of this species are illustrated herein for the first time.

Loxoconcha kosugii n. sp.
(Figs 15, 16)

Loxoconcha sp.: Tsukagoshi and Kamiya 1996: 366, fig. 18E–H.

Types. Holotype, SUM-CO-1174 (complete male carapace, length: 0.640 mm, height: 0.341 mm, width: 0.316 mm); paratypes, SUM-CO-1175 (complete male carapace), SUM-CO-1176 (complete female carapace), SUM-CO-1177 (complete female carapace), SUM-CO-1178 (complete male carapace), SUM-CO-1179 (complete female carapace), SUM-CO-1180 (LV of male), SUM-CO-1181 (RV of male), SUM-CO-1182 (LV of female), SUM-CO-1183 (RV of female), SUM-CO-1184 (RV, LV, and soft parts of male), SUM-CO-1185 (RV and LV of female), SUM-CO-1186 (soft parts of male), and SUM-CO-1187 (RV, LV, and soft parts of male).

Etymology. Named in honor of the late Dr. Masato Kosugi (Nihon University).

Type locality. Loc. 24: creek of delta swamp at Mouth of Obitsu River, Kisarazu City, Chiba Prefecture, Japan (35°24.6′N, 139°53.6′E), sandy mud bottom, water depth *ca* 5 cm at lowest low tide.

Diagnosis. Carapace rhomboidal in lateral view, dorsal and ventral margins straight and almost parallel (Fig. 15A–D). Sexual dimorphism strong. Carapace of male elongate with posterior half inflated. Surface covered with obvious reticulations and sieve-type pore systems with wide openings arranged in concentric rows

(paratype, SUM-CO-1182); J, female RV in internal lateral view (paratype, SUM-CO-1183); K, muscle scars of female RV (paratype, SUM-CO-1183); L, M, anterior and posterior elements of hingement on male RV (paratype, SUM-CO-1181). Scale bar=300 μm for A–J, 50 μm for K–M.

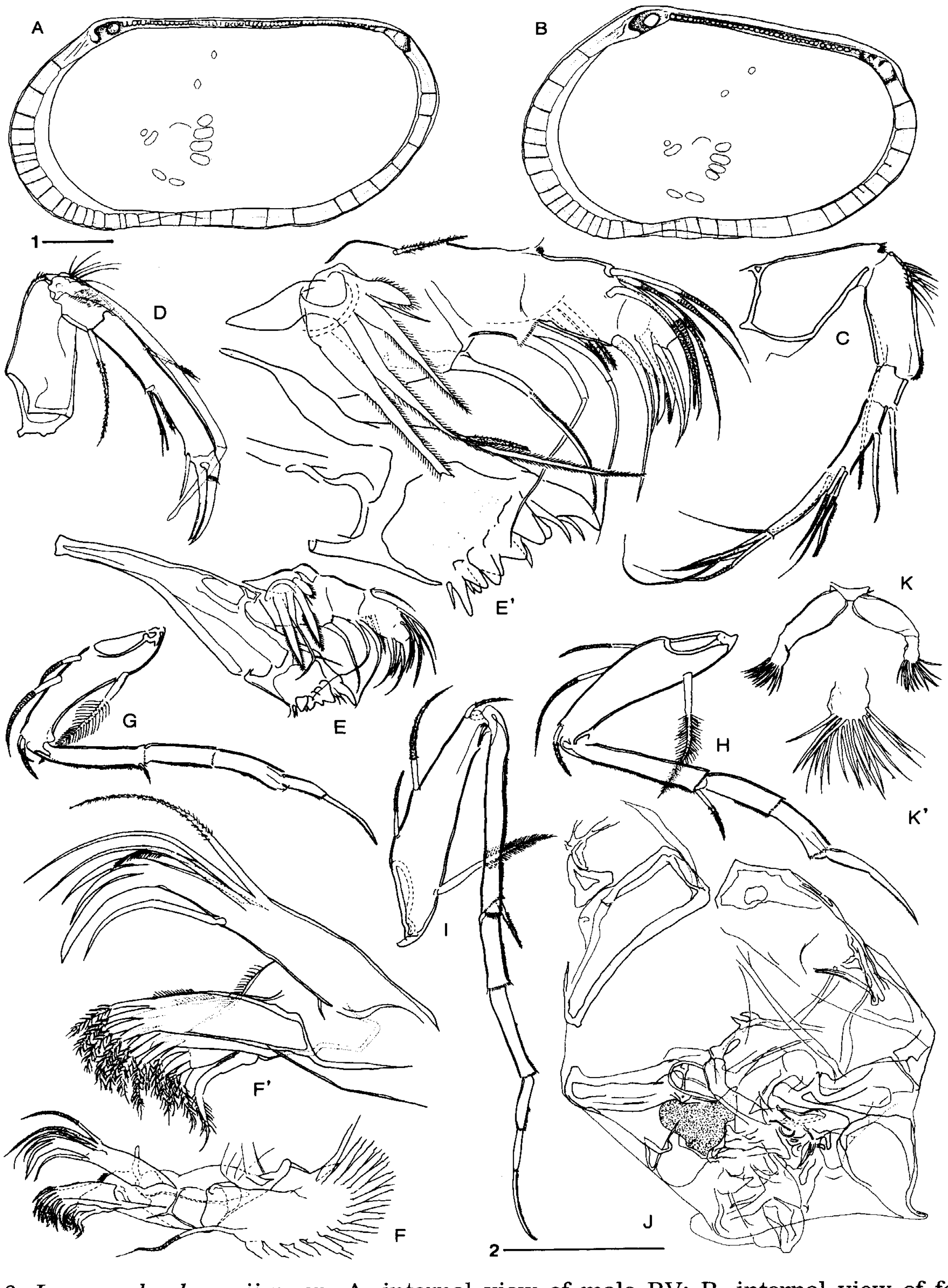

Fig. 16. *Loxoconcha kosugii* n. sp. A, internal view of male RV; B, internal view of female RV; C, antennule; D, antenna; E, mandible; F, maxillule; G, first thoracic leg; H, second thoracic leg; I, third thoracic leg; J, copulatory organ of male; K, brush-shaped organ; E', F', and K', enlarged details of E, F, and K, respectively. A, SUM-CO-1184 (paratype, male); B, SUM-CO-1185 (paratype, female); C–I and K, SUM-CO-1186 (paratype, male); J, SUM-CO-1187 (paratype, male). Scale bar 1=100 μm for A and B. Scale bar 2=140 μm for J, 100 μm for C–I and K, 40 μm for E', F', and K'.

running subparallel to anterior, ventral, and posterior margins. Marginal infoldment narrow (Fig. 15G–J), especially in posterior half. In male copulatory organ (Fig. 16J), large distal lobe thin especially along distal margin and making tip. Large, thin clasping apparatus overlapping distal lobe with distal end extending outside distal margin of latter. Copulatory duct very fine, short, and folded inside inner margin of distal lobe.

Description. Hingement (Fig. 15L, M): gongylodont; on RV, single large tooth surrounding by depression in anterior element; numerous fine teeth in median element; few small teeth and 1 large tooth in posterior element. Muscle scars (Figs 15K, 16A, B): 2 separate frontal scars; 2 elongate mandibular scars; 4 adductor scars. Very narrow vestibules anteriorly and posteriorly. Antennule (Fig. 16C): 6 segments, with 4th and 5th segments fused; distal segment bearing 2 long and 2 short setae. Antenna (Fig. 16D): 4 articulated segments; 4th segment bearing 2 claw-like setae with serrations at distal end and on ledge, respectively. Mandible (Fig. 16E, E'): 5 articulated segments; coxa bearing teeth on medial edge and plumose seta on anterior distal margin; basis bearing exopodite as bunch of 4 plumose setae (one of them extremely reduced) and 1 short, simple seta; 1st segment of endopodite bearing 2 short and 1 medium-long plumose setae, and 2 long setae (one of them with short, fine hairs arranged in row); 2nd segment of endopodite bearing 6 setae on ledge and 2 setae at distal end; 3rd segment of endopodite bearing 4 simple setae and 1 short, plumose seta. Maxillule (Fig. 16F, F'): thin branchial plate with 16 plumose setae; basal podomere bearing palp and 3 endites; palp and each endite with several equal-length, plumose setae. Thoracic legs (Fig. 16G–I): all 3 legs 4-segmented and similar in shape; joint-like constrictions with short, fine hairs in distal claw-like seta.

Remarks. The records presented herein are from the lowest salinity site for any extant species of *Loxoconcha* reported from Japan. This species resembles *L. uranouchiensis* Ishizaki, 1968, but it has more sharp muri on its carapace and more elongate distal lobe on the male copulatory organ.

Loxoconcha pulchra Ishizaki, 1968
(Figs 17, 18)

Loxoconcha pulchra Ishizaki, 1968: 31, pl. 1, fig. 16, pl. 7, figs 19, 20; Ikeya *et al.* 1985, pl. 7, figs 1–5; Kamiya and Nakagawa 1993, pl. 6, figs 4, 5; Irizuki and Matsubara 1994, pl. 1, fig. 18; Yamane 1998, pl. 6, fig. 5; Irizuki and Hosoyama 2000, fig. 3 (16).

Not *Loxoconcha pulchra*: Tsukagoshi *et al.* 1994, pl. 2/28, figs 1–6. [*Loxoconcha* sp., undescribed species]

Diagnosis. Carapace rhomboidal in lateral view (Fig. 17A–D). Upper half of posterior margin straight and oriented obliquely upward. Modest ala developed ventrally. Carapace surface covered with numerous fine pits and scattered sieve-type pore systems. Hingeline almost straight. Marginal infoldment narrow. In male copulatory organ (Fig. 18H), large distal lobe thin especially along distal margin. Thumb-like clasping apparatus precisely overlapping distal part of distal lobe. Copulatory duct fine and folded.

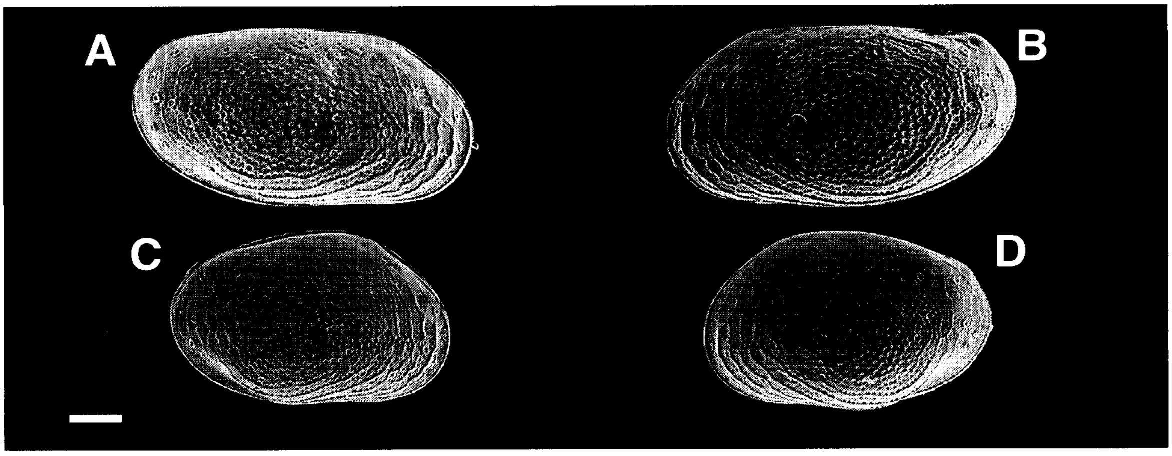

Fig. 17. *Loxoconcha pulchra* Ishizaki, 1968. A, male carapace in external right lateral view (SUM-CO-1188); B, male carapace in external left lateral view (SUM-CO-1189); C, female carapace in external right lateral view (SUM-CO-1190); D, female carapace in external left lateral view (SUM-CO-1191). Scale bar=100 μm.

Description. Antennule (Fig. 18A): 6 segments, with 4th and 5th segments fused; distal segment bearing 3 simple setae and claw-like seta, latter with fine, short hairs on distal part of anterior margin. Antenna (Fig. 18B): 4 articulated segments; stout seta with short, fine hairs at distal end of third segment; 4th segment bearing 2 claw-like setae with serrations at distal end and on ledge, respectively. Mandible (Fig. 18C, C'): 5 segments; coxa bearing teeth, short, simple hair, and 2 comb-like structures; basis bearing exopodite as small branchial plate with few soft setae; first segment of endopodite bearing 3 long setae and 2 short setae; 2nd segment bearing 6 long setae on ledge, two simple setae and 1 stout, plumose seta at distal end; 3rd segment bearing 2 stout setae and 1 plumose seta at distal end. Maxillule (Fig. 18D, D'): thin branchial plate with 16 setae; basal podomere bearing palp and 4 endites; palp with 5 long setae and 3 stout setae; distal 3 endites bearing 6, 7, and 4 setae, respectively; proximal endite bearing long hairs arranged in 2 rows and terminating in spatula-like head. Thoracic legs (Fig. 18E–G): all 3 legs 4-segmented and similar in shape; all legs terminating in claw-like seta with short, fine hairs and joint-like constrictions.

Remarks. Illustrations of the soft parts of this species are presented herein for the first time.

Cytheromorpha acupunctata (Brady, 1880)
(Fig. 19)

Cythere acupunctata Brady, 1880: 68, pl. 14, fig. 1a–h.

Cytheromorpha acupunctata: Hanai 1961a: 371, text-fig. 12, fig. 2a, b; Ishizaki 1968: 35–36, pl. 7, figs 17, 18; 1969: 220, pl. 26, figs 5, 6; 1971: 90, pl. 3, fig. 13; Okubo 1978: 90–93, figs 1a–f, 2, 4a–h; Ikeya 1982, fig. 1889a–c; 1983: 2, fig. 1 (3); Ishizaki 1984, pl. 1 (3); Ikeya *et al.* 1985, pl. 8, figs 7, 10–12; Ishizaki and Matoba 1985, pl. 3, figs 3, 4; Ikeya *et al.* 1987, pl. (1), figs 9–11; Bodergat and Ikeya 1988: 421, text-fig. 4a; Ikeya and Ueda 1988: 329, pl. 1, figs a–m, pl. 2, figs a–o, pl. 3, figs 1–3, text-figs 6,

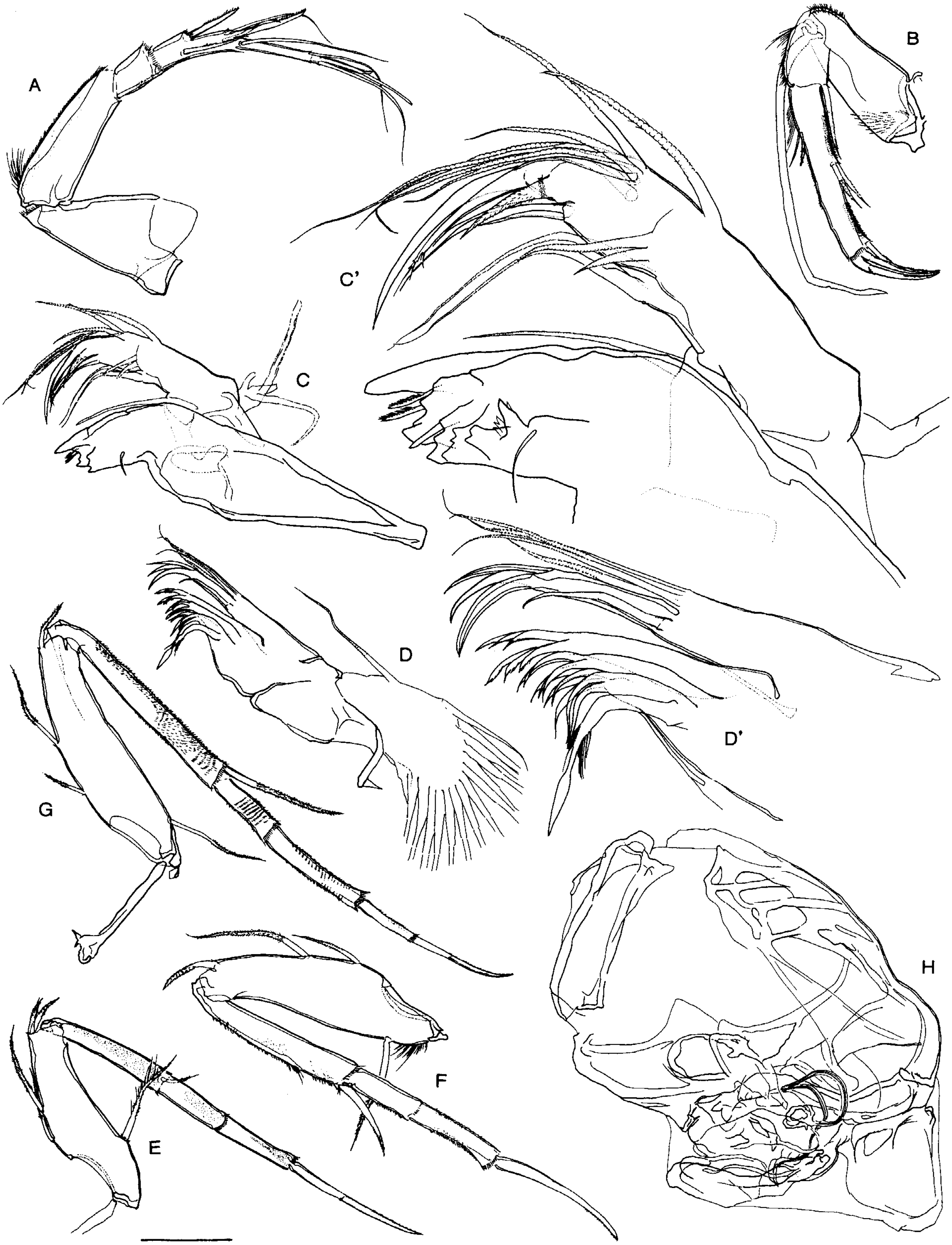

Fig. 18. *Loxoconcha pulchra* Ishizaki, 1968. A, antennule; B, antenna; C, mandible; D, maxillule; E, first thoracic leg; F, second thoracic leg; G, third thoracic leg; H, copulatory organ of male; C' and D', enlarged details of C and D, respectively. A–H, SUM-CO-1192 (male). Scale bar=50 μm for A–G, 20 μm for C' and D', 80 μm for H.

7; Paik and Lee 1988: 552, pl. 3, fig. 19; Wang, Q. *et al.* 1988, pl. 1, fig. 26; Ishizaki 1990, fig. 1 (3); Takayasu *et al.* 1990, fig. 16; Yajima and Lord 1990, fig. 5 (4, 5); Ikeya and Itoh 1991, fig. 14C; Ikeya 1993, fig. 3 (1A–E); Ikeya and Shiozaki 1993: 17, fig. 2 (1A–E); Tsukagoshi *et al.* 1994, pl. 2/29, figs 1–8; Ozawa 1996, pl. 3, fig. 10; Irizuki *et al.* 1998, fig. 8 (10); Tanaka *et al.* 1998, pl. 1, fig. 5; Yamane 1998, pl. 4, fig. 6; Irizuki *et al.* 1998, fig. 3 (10); 1999, fig. 1 (B-3); Fujiwara *et al.* 2000, fig. 3; Irizuki and Hosoyama 2000, fig. 3 (15).

Cytheromorpha japonica Ishizaki, 1968: 36, pl. 9, figs 11, 12; 1969: 221, pl. 26, fig. 16; Wang and Zhang 1987, pl. 2, fig. 33; Wang, Q. *et al.* 1988, pl. 1, fig. 27. [Synonymized by Hanai 1977]

Diagnosis. Great sexual dimorphism evident in lateral view; males elongate, females triangular-quadrate. Highest point 1/3 and 1/4 from anterior end in female and male, respectively. Hingeline almost straight. Carapace surface covered with conspicuous reticulations or fine pits (large variation of carapace ornamentation known). Modest ridges in anterior and posterior zones. Sulci in post-ocular and dorsomedian areas.

Remarks. Ikeya and Ueda (1988) showed a seasonal change between coarse and fine carapace ornamentation in this species in Lake Hamana-ko. Intermediate and fine-type ornamentation appeared in the present study area.

Cytherois ikeyai n. sp.
(Figs 20, 21)

Types. Holotype, SUM-CO-1196 (compete male carapace, length: 0.266 mm, height: 0.106 mm, width: 0.100 mm); paratypes, SUM-CO-1197 (complete male carapace), SUM-CO-1198 (complete female carapace), SUM-CO-1199 (complete female carapace), SUM-CO-1200 (complete male carapace), SUM-CO-1201 (complete female

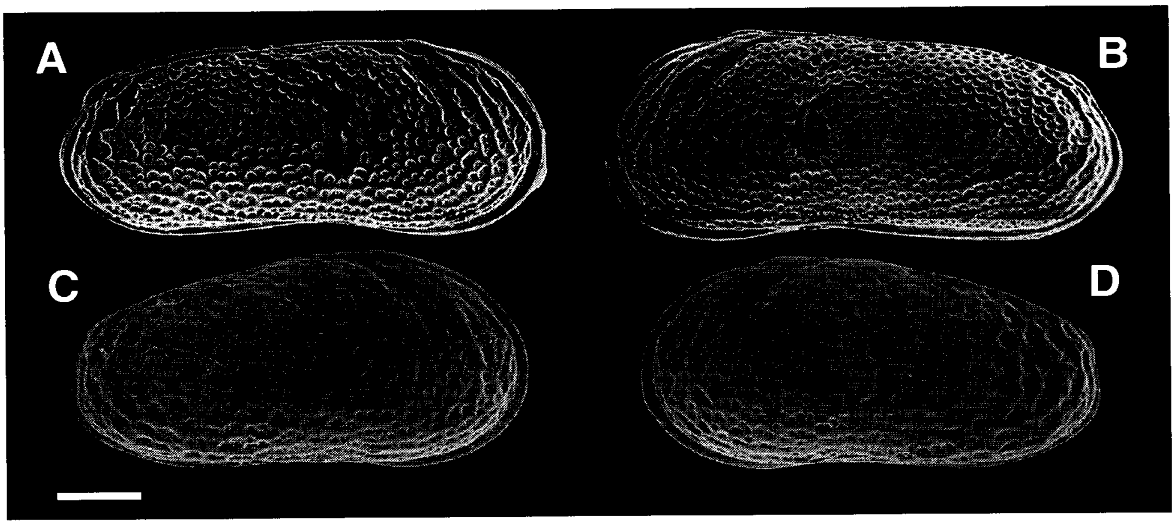

Fig. 19. *Cytheromorpha acupunctata* (Brady, 1880). A, male carapace in external right lateral view (SUM-CO-1193); B, male carapace in external left lateral view (SUM-CO-1194); C, D, female RV and LV in external lateral view (SUM-CO-1195). Scale bar=100 μm.

carapace), SUM-CO-1202 (LV of female), SUM-CO-1203 (RV of female), SUM-CO-1204 (RV of male), SUM-CO-1205 (RV of male), SUM-CO-1206 (RV of female), and SUM-CO-1207 (soft parts of male).

Etymology. In honor of Prof. Noriyuki Ikeya (Shizuoka University).

Type locality. Loc. B: small creek within halophilous glass at mouth of Obitsu River, Kisarazu City, Chiba Prefecture, Japan (35°24.6′N, 139°54.2′E), muddy sand bottom, depth *ca* 5 cm at lowest low tide.

Diagnosis. Carapace in lateral view with posterior half of dorsal margin broadly arched, anterior half straighter with pronounced change in slope (Fig. 20A–D). In male, distal segment of antennule bearing spatulate seta and 4th segment of antenna bearing sucker-like organ at distal end of inner margin (Fig. 21C, D). Male copulatory organ with almost circular capsule and flat trapezoidal distal lobe bearing leaf-like process proximally (Fig. 21J). Copulatory duct not very long and coiling once at its proximal end.

Description. Carapace thin and fragile, that of female larger than that of male in length and height. Hingement (Fig. 20J, K): lophodont; median element very long; all elements non-crenulate. Muscle scars (Figs 20I, 21A, B): each scar elongate; 2 separated mandibular scars. Vestibule well developed anteriorly and postero-ventrally. Antennule (Fig. 21C): 6 articulated segments; 2nd segment very long; 6th (distal) segment bearing 3 simple and 1 spatula-like setae. Antenna (Fig. 21D): 4 articulated segments; length of 2nd segment almost equal to that of 1st segment; 4th segment bearing 2 claw-like setae and sucker-like organ. Mandible (Fig. 21E): 5 segments with 2nd and 3rd segments of endopodite almost fused; coxa bearing poor developed teeth; basis bearing exopodite reduced to simple, long setae; 1st segment of endopodite long and lacking setae; 2nd segment bearing 5 simple setae at distal end; 3rd segment bearing 3 stout and 4 relatively thin setae at distal end. Maxillule (Fig. 21F): thin branchial plate with about 12 setae; basal podomere bearing palp and 3 endites; palp with 5 setae and each endite with 3 setae. Thoracic legs (Fig. 21G–I): all 3 legs 4-segmented and similar in shape; 2nd segment of each bearing stout setae at distal end.

Remarks. This species resembles *C. bingoensis* Okubo, 1980 in carapace outline. Okubo (1980c) did not illustrate the male copulatory organ, but the distal structure of the male second antenna of *C. ikeyai* n. sp. is clearly distinct from that of *C. bingoensis*.

Discussion

This research compensates for the previous lack of information on intertidal brackish-water ostracod faunas in Japan. Twenty-one species of Ostracoda, including five previously undescribed species, occurred in the study area. The five species for which only valves were found probably being allochthonous, one-third of the native estuarine species we examined were thus previously undescribed. Furthermore, the soft parts of four previously described taxa have been illustrated here for the first time (previously, only their carapace morphology had been described).

Frydl (1982) studied the ostracod fauna in areas adjacent to the southern part of the present study area, specifically the Recent fauna of Tateyama Bay and fossil

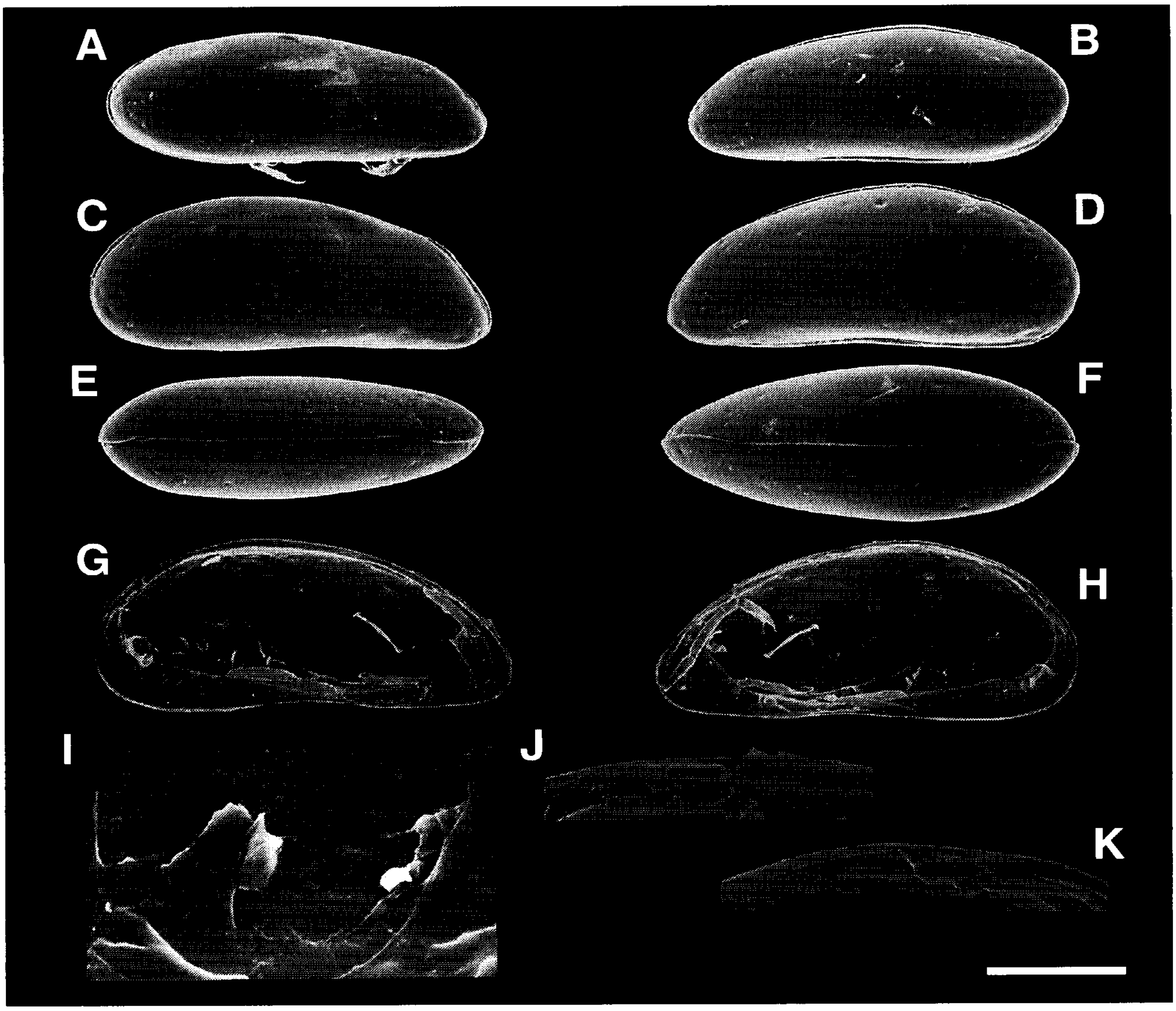

Fig. 20. *Cytherois ikeyai* n. sp. A, male carapace in external right lateral view (holotype, SUM-CO-1196); B, male carapace in external left lateral view (paratype, SUM-CO-1197); C, female carapace in external right lateral view (paratype, SUM-CO-1198); D, female carapace in left lateral view (paratype, SUM-CO-1199); E, male carapace in external dorsal view (paratype, SUM-CO-1200); F, female carapace in external dorsal view (paratype, SUM-CO-1201); G, female left valve in internal lateral view (paratype, SUM-CO-1202); H, female right valve in internal lateral view (paratype, SUM-CO-1203); I, muscle scar of male right valve (paratype, SUM-CO-1204); J, K, hingements of female right valve (paratype, SUM-CO-1203). Scale bar=110 μm for A-H, 17 μm for I, 30 μm for J and K.

remains in Holocene sediment from the Numa Formation. He listed 83 and 111 species from these localities, respectively. Only three species from Tateyama Bay (*Spinileberis quadriaculeata*, *Mutilis assimilis*=*Robustaurila ishizakii*, and *Cytheromorpha acupunctata*) and five species from the Holocene Numa Formation (*Tanella pacifica*=*Ishizakiella miurensis*, *Spinileberis quadriaculeata*, *Aurila* sp., *Mutilas assimilis*=*Robustaurila ishizakii*, and *Cytheromorpha acupunctata*) are shared with the Obitsu Estuary fauna of this study. In Tateyama Bay, sediments shallower than 5 m in depth were not sampled and the intertidal estuarine fauna

Fig. 21. *Cytherois ikeyai* n. sp. A, internal view of male RV; B, internal view of female RV; C, antennule; D, antenna; E, mandible; F, maxillule; G, first thoracic leg; H, second thoracic leg; I, third thoracic leg; J, copulatory organ of male. A, SUM-CO-1205 (paratype); B, SUM-CO-1206 (paratype); C–J, SUM-CO-1207 (paratype, male). Scale bar 1=10 μm for A and B, scale bar 2=20 μm for C–J.

Table 3. Numbers of individuals of the ostracod species per 200 cc sediment at each sampling point in May, 1998.

Loc. No.	Species	*Il. dentifera*	*D. mukaishimensis*	*Pe. japonica*	*Po. miurensis*	*Po. xiphoidea*	*Ca. pumila*	*Is. miurensis*	*Pa. migrans*	*Sp. pulchra*	*Sp. quadriaculeata*	*Au. disparata*	*R. ishizakii*	*B. bisanensis*	*An. miii*	*H. tricarinata*	*H. sp*	*Se. wakamurasaki*	*L. kosugii*	*L. pulchra*	*Cy. acupunctata*	*Cy. ikeyai*	Total
1	L			72				120											640	24			856
	D			236	12			28							12				138	84			510
3	L			4				28												455		4	491
	D			12				8												528		4	552
5	L			2	33	5	1	6										3		107			157
	D			59	41	7	1	1					1					7		154	1	2	274
6	L			1	3	1		1										1		8			15
	D			1	11	7					1							1		8			29
7'	L																						
	D																						
11	L							12											19	1			32
	D		1	57				5							25				96	11		23	218
11'	L							8												88			96
	D			816				72							160				32	976		104	2,160
12	L							7															7
	D			94				4							88				17			19	222
14	L		6					4											1				11
	D		30					3	1	10									2				46
16	L																						
	D																						
18	L			1				2												5			8
	D			2																2		1	5
21	L							32											28				60
	D			18				26							8				74			4	130
24	L				8			19,952											456				20,416
	D		24	8		8		2,120											528				2,688
25	L							4,184											16				4,200
	D							664							64				24	8			760
A	L							2,816											376				3,192
	D							696											368				1,064
B	L							424											248				672
	D			8				96							24				176				304
F	L							2															2
	D							6							2				4				12

L: living, D:dead

Table 4. Numbers of individuals of the ostracod species per 200 cc sediment at each sampling point in July, 1998.

Loc. No.	Species	*Il. dentifera*	*D. mukaishimensis*	*Pe. japonica*	*Po. miurensis*	*Po. xiphoidea*	*Ca. pumila*	*Is. miurensis*	*Pa. migrans*	*Sp. pulchra*	*Sp. quadriaculeata*	*Au. disparata*	*R. ishizakii*	*B. bisanensis*	*An. miii*	*H. tricarinata*	*H.* sp	*Se. wakamurasaki*	*L. kosugii*	*L. pulchra*	*Cy. acupunctata*	*Cy. ikeyai*	Total
1	L			22				31											214	39			306
	D			2															19	2			23
3	L			696	80			40												1,472			2,288
	D			400	48															848			1,296
5	L			240	1,224		24	112										16		1,416			3,032
	D			136	136	16								8						352			648
6	L				102	64	2	12										8		220	2		410
	D			20	18	12		6						2		1		2		54	2		117
7'	L																						
	D			2	3																		5
11	L		2	13				16											13	7			51
	D			3				1											2	3			9
11'	L			1				13											3	5			22
	D			1				1															2
12	L																						
	D			6															2	8			16
14	L		3					46		1									1				51
	D		3					1		15									1				20
16	L																						
	D																						
18	L		1	4				5												21			31
	D			9	2			1				1			2		2		1	28			46
21	L		2					104	4	2										206			318
	D																			10			10
24	L		8					6,136											344	8			6,496
	D							104											80				184
25	L		7					4,837											51				4,895
	D							139											7				146
A	L							480											127				607
	D							40											49				8
B	L	1	10	1				113											17	3			145
	D		5	9				8							2				9	6			39
F	L																						
	D																						

L: living, D:dead

Table 5. Size dimensions, site of occurrences, and salinity range at main didtribution points (SRDP) of each species.

Species name		Dimensions (mm) Length		Height			Width			Occurrences	SRDP
		Av.	OR	Av.	OR	N	Av.	OR	N	(Loc. No.)	‰
Ilyocypris dentifera	Male	0.67	0.60–0.70	0.38	0.36–0.39	5	0.26	0.26–0.27	2	11, B	21
	Female	0.77	0.72–0.84	0.42	0.40–0.48	6	0.26	–	1		
Dolerocypria mukaishimensis		0.67	0.65–0.68	0.27	0.23–0.30	10	0.21	0.19–0.22	4	11, 14, 21, 24 25, A, B	11–19
Perissocytheridea? japonica	Male	0.67	0.64–0.69	0.31	0.29–0.32	10	0.33	0.30–0.38	10	1, 3, 5	19–28
	Female	0.60	0.57–0.63	0.32	0.29–0.34	10	0.33	0.32–0.35	10		
Pontocythere miurensis	Male	0.61	0.58–0.64	0.25	0.23–0.26	10	0.24	0.22–0.27	10	3, 5, 6	23–27
	Female	0.56	0.53–0.57	0.26	0.23–0.30	10	0.25	0.24–0.27	10		
Pontocythere xiphoidea	Male	0.53	0.47–0.62	0.20	0.18–0.23	6	0.18	0.17–0.19	6	3, 5, 6	23–27
	Female	0.53	0.51–0.56	0.22	0.20–0.24	10	0.22	0.20–0.24	10		
Callistocythere pumila	Male	0.48	–	0.25	–	1	0.18	–	1	5, 6	27
	Female	–	–	–	–	–	–	–	–		
Ishizakiella miurensis	Male	0.56	0.53–0.58	0.28	0.26–0.29	10	0.23	0.22–0.24	10	1, 3, 5, 6, 11, 11′,12, 14, 18, 21, 24, 25, A, B, F	3–25
	Female	0.62	0.59–0.64	0.31	0.30–0.32	10	0.32	0.29–0.34	2		
Palusleptocythere migrans	Male	0.40	0.39–0.41	0.22	0.21–0.23	10	0.16	0.15–0.17	10	21, 24, B	6–24
	Female	0.40	0.38–0.41	0.24	0.22–0.25	10	0.17	0.17–0.18	10		
Spinileberis pulchra	Male	0.59	0.58–0.60	0.32	0.32–0.33	2	0.23	0.22–0.24	2	14, 21, A, B	2–24
	Female	0.63	0.57–0.67	0.37	0.35–0.39	10	0.31	0.29–0.34	10		
Spinileberis quadriaculeata	Male	–	–	–	–	–	–	–	–	7′	24<
	Female	0.54	–	0.34	–	1	0.30	–	1		
Aurila disparata	Male	0.69	–	0.56	–	1	–	–	–	18	–
	Female	–	–	–	–	–	–	–	–		
Robustaurila ishizakii	Male	0.64	–	0.38	–	1	–	–	–	5	–
	Female	–	–	–	–	–	–	–	–		
Bicornucythere bisanensis	Male	0.88	–	0.54	–	1	–	–	–	5, 6, 18	–
	Female	0.84	–	0.55	–	1	–	–	–		
Angulicytherura? miii	Male	0.62	0.59–0.67	0.30	0.29–0.32	10	0.28	0.27–0.29	10	1, 11, 11′, 24, 25, B	4–23
	Female	0.54	0.51–0.56	0.28	0.26–0.29	10	0.27	0.24–0.28	10		
Hemicytherura tricarinata	Male	0.36	–	0.2	–	1	–	–	–	6	–
	Female	–	–	–	–	–	–	–	–		
Hemicytherura sp.	Male	0.37	0.37–0.38	0.22	0.22–0.22	2	–	–	–	18	–
	Female	–	–	–	–	–	–	–	–		
Semicytherura wakamurasaki	Male	0.36	–	0.18	–	1	0.16	–	1	5, 6, 18	23–27
	Female	0.35	–	0.19	–	1	0.16	–	1		
Loxoconcha kosugii	Male	0.66	0.61–0.69	0.35	0.32–0.37	10	0.33	0.30–0.36	10	1, 3, 5, 6, 11, 11′, 14, 12, 18, 21, 24, 25, A, B, F	16–28
	Female	0.55	0.52–0.58	0.34	0.32–0.35	10	0.29	0.27–0.32	10		
Loxoconcha pulchra	Male	0.61	0.59–0.61	0.35	0.34–0.35	10	0.32	0.31–0.33	10	1, 3, 5, 6, 12, 18, 21, 24, A, F	21–28
	Female	0.49	0.46–0.50	0.33	0.31–0.34	10	0.28	0.27–0.31	10		
Cytheromorpha acupunctata	Male	0.64	–	0.28	–	1	0.22	–	1	6	27
	Female	0.55	–	0.28	–	1	0.22	–	1		
Cytherois ikeyai	Male	0.26	0.25–0.28	0.11	0.09–0.12	10	0.1	0.09–0.12	10	3, 5, 11, 11′ 21, B, F	15–27
	Female	0.29	0.28–0.30	0.13	0.13–0.14	10	0.13	0.12–0.13	10		

remains unknown. It is expected that the intertidal fauna (shallower than 5 m) should be different from that of an inner bay environment. Frydl (1982) did not use any inventories of ostracods from estuarine environments in his reconstructions of the paleoenvironment of the Japanese Holocene. Besides Frydl's work, the common species listed above have been reported recently from other Holocene deposits (e.g., Tsukagoshi *et al.* 1994; Irizuki *et al.* 1998, 1999; Fujiwara *et al.* 2000; Irizuki and Hosoyama 2000); however, those assemblages were not interpreted as estuarine.

More recently, analysis of Holocene deposits using "sequence stratigraphy" has resulted in an increased interest in non-marine and brackish-water deposits. It is critical to take the estuarine environment, situated between sea and land, into consideration in detailed paleoenvironmental interpretation of Holocene deposits and estimation of associated sea-level fluctuations. When fossil ostracods from such estuarine deposits are reported, the present study may provide a guide to paleoenvironmental reconstruction.

In 1997 an express way, the "Tokyo Bay Aqualine" connecting the west and east sides of Tokyo Bay, was completed. The eastern half of the highway is a bridge that passes within 2 km of the present study area, while the remainder of the road progresses via a long undersea tunnel. The effect of the "Aqualine" highway on the estuarine environment of Tokyo Bay is not yet known, but sediments containing ostracods from this study area have been collected since the latter half of the 1980s and analysis of the ostracod faunal associations may facilitate monitoring of changing environments over the past decade and into the future. In order to use ostracods in biomonitoring, the seasonal population dynamics of key indicator species must be understood, and the present study represents the first step towards that end.

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